UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF CHEMICAL SAFETY AND POLLUTION PREVENTION

MEMORANDUM

Date: February 6, 2014

SUBJECT: Glyphosate: Tier II Incident Report

PC Code: 103601, 103603, 103604, 103605, 103607, 103608, 103613, 417300
Decision No.: 487242
Petition No.: NA
Risk Assessment Type: NA
TXR No.: NA

MRID No.: NA

DP Barcode: D417808

Registration No.: NA
Regulatory Action: NA
Case No.: NA
CAS No.: 38641-94-0, 70393-85-0, 40465-66-5, 114370-14-8, 70901-12-1, 1071-83-6
40 CFR: NA

Ver.Apr.08

FROM: Shanna Recore, Industrial Hygienist
Carol Christensen, Epidemiologist
Elizabeth Evans, Environmental Protection Specialist
Khin Oo, MD, DABT, Environmental Health Scientist
Toxicology and Epidemiology Branch
Health Effect Division (7509P)

THROUGH: David J. Miller, Acting Chief
Toxicology and Epidemiology Branch
Health Effects Division (7509P)

06-Feb-2014

TO: Thomas Bloem, Risk Assessor
Risk Assessment Branch I
Health Effects Division (7509P)

SUMMARY

HED is currently re-evaluating the toxicity, exposure, and risk profile of glyphosate under the Food Quality Protection Act (FQPA)-mandated Registration Review program. The registration review program is designed to ensure EPA evaluates new information regarding pesticides on a 15 year cycle, and to update the risk assessment and initiate new regulatory requirements, when appropriate, to ensure the protection of human health and the environment. Pesticides included in

the registration review program are pesticides for which EPA completed a Re-registration Eligibility Decision (RED) under the FQPA.

One component of the Agency's Registration Review Program is consideration of acute and chronic health effects observed in the human population as a possible consequence of glyphosate exposure. Given the magnitude and frequency observed in the initial screening evaluation of acute poisoning incidents related to glyphosate use, HED determined that a more extensive Tier II report of the acute and chronic human health effects linked to glyphosate use should be performed. A Tier II report provides additional details and greater depth in scope of review information relating to human exposure. Information streams queried for this report include acute pesticide poisoning event (incident data) and surveillance data, medical case reports of human exposure to glyphosate, general medical information, biomonitoring data, and observational epidemiology studies. Utilization of these data will aid HED in better defining and characterizing the potential risk of glyphosate pesticide products to the U.S. population, and particular sub-groups such as workers and children.

A review of medical literature finds most of the accidental ingestions of glyphosate formulations resulted in mild symptoms such as irritation of oral and upper gastrointestinal mucosa and were self limited. However, intentional ingestions caused moderate to severe symptoms in multiple organs.

HED reviewed five pesticide incident data sources (IDS, NPIC, California PISP, NIOSH/SENSOR, and AAPCC). HED found that the acute health effects reported to the incident databases queried are consistent with the previous incident report, and the other databases and medical literature reviewed. These health effects primarily include dermal, ocular, and respiratory. HED did not identify any aberrant effects outside of those anticipated. While inconvenient for those who suffer adverse health effects, effects are generally mild/minor to moderate and resolve rapidly. The incident data available from IDS and NPIC suggest that homeowner mixing/loading/ applying (usually due to human errors and container leaks of glyphosate products) are responsible for almost half of the reported incidents. SENSOR-Pesticides incident data are consistent with IDS and NPIC, also suggesting that most reported incidents (50%) occur during application of glyphosate results. . However, the SENSOR-Pesticide incidents include both residential and occupational incidents. The incident data available from CA PISP suggests that occupational handling of equipment is responsible for most incidents due to equipment leaks and malfunction.

All of the databases showed a number of childrens' exposures (ranging from 5% to 27% of total cases). Based on the data in SENSOR, IDS, and NPIC, it appears that the childrens' exposures are due to primarily to postapplication exposure, accidental ingestion, and tampering with the product.

Ocular exposure and symptoms were reported in all of the databases, to both occupational and nonoccupational users, as a result of splash to the face or touching their eyes with the product on their hands. These symptoms primarily included eye irritation, redness, burning and blurred vision.

Trends over time data from IDS (2008 to 2012), PISP (2005 to 2010), SENSOR-Pesticides (1998 to 2009) and AAPCC (2001 to 2012) data were reviewed. Based on IDS and AAPCC, which are primarily non-occupational cases, incidents appear to be decreasing over time. CA PISP data represents both occupational and non-occupational incidents. This data appears to show incidents to be relatively steady over time. The SENSOR-Pesticide data also represent both occupational and non-occupational cases. For this data, occupational case reports involving glyphosate appeared to be increasing until 2008 and non-occupational case reports appear to be increasing over time. The increase in non-occupational case reports may be reflective of increased SENSOR state capacity to collect non-occupational pesticide surveillance data.

While HED identified several dozen glyphosate environmental epidemiology studies, few of these studies reflected an *a priori* research interest in the potential role of glyphosate and chronic disease outcomes, and most studies were hypothesis-generating in nature. Given this and other limitations of these studies, we cannot conclude glyphosate plays a role in any of the health outcomes studied across this epidemiologic database. EPA will continue to follow the literature concerning the potential role of the chemical in certain cancer and non-cancer outcomes, particularly respiratory health and lymphohematopoietic cancers such as non-Hodgkin lymphoma (NHL) and multiple myeloma (MM).

1. BACKGROUND

Glyphosate is a nonselective herbicide which acts via blocking the activity of the enzyme, 5-enolpyruvylshikimate 3-phosphate synthase (EPSPS). EPSPS is produced only by green plants and is involved in the synthesis of the amino acids tyrosine, tryptophan, and phenylalanine.

Glyphosate is registered for use on a variety of fruit, vegetable, and field crops as well as for aquatic and terrestrial uses. It is also registered for use on transgenic crop varieties such as canola, corn, cotton, soybeans, sugar beets, and wheat. Glyphosate was first registered for use by the United States Environmental Protection Agency (U.S. EPA) in 1974 and reregistration was completed in 1993. Glyphosate is among the most widely used pesticides by volume. It ranked eleventh among conventional pesticides used in the U.S. during 1990-91. In recent years, approximately 13 to 20 million acres were treated with 18.7 million pounds of glyphosate annually. The largest use sites include hay/pasture, soybeans and field corn (D362745, 06/03/2009, J. Langsdale et al.).

In March 2009, HED prepared a preliminary Tier I human incident review of glyphosate human incident reports by consulting the OPP Incident Data System (IDS) for reports of poisoning incidents. During the time period captured in the screening report, 2002 to March 2009, 289 incidents involved products containing the single active ingredient glyphosate. Based on the IDS, 8 major types of adverse health effects were identified: gastro-intestinal (4.8%), dermal (30.1%), upper-respiratory (10.3%), neurological (34.3%), cardiovascular (0.3%), ocular (13.8%), muscular (0.3%), and combination (5.5%) effects (*Updated Review of Glyphosate Incident Reports*, M. Hawkins and J. Cordova, 03/12/2009). Given the frequency and relative severity, HED determined it would further evaluate glyphosate acute poisoning event reporting and surveillance databases as well as a review of published literature as to the acute and chronic health effects associated with glyphosate exposure by performing a Tier II review.

It is important to recognize, however, that reports of adverse health effects allegedly due to a specific pesticide exposure (i.e., an "incident") are largely self-reported and therefore, generally speaking, neither exposure to a pesticide or reported symptoms (or the connection between the two) are validated. Therefore, only rarely can causation be determined or definitively identified based on incident data. However, incident information can provide important feedback to the Agency. Human incident data, in concert with other human observational studies (medical case reports, general medical information, biomonitoring and epidemiological studies) and the human health risk assessment, can assist the Agency in determining potential risks of pesticides/pesticide product exposure, and can help characterize that risk. This review assesses acute pesticide poisoning incidents, medical case reports, and published epidemiology studies to inform the preliminary risk assessment for glyphosate.

a. Tier II Overview

Historically, the Agency has relied on toxicity studies conducted on animals and exposure information measured or modeled in relevant populations regarding the pesticide's use pattern when considering the registration or re-registration of a pesticide. While the use of these data, models and standard exposure assumptions will likely not diminish, the relevance of human data that report acute and chronic health effects experienced in the population will continue to increase. Improved exposure assessment methods, use of biomarkers of disease as well as exposure, and continued merging of toxicology and epidemiology through adverse outcome pathway/MOA framework analysis and molecular epidemiology methods will enhance the utility of public health data as a stream of evidence in the risk assessment.

Tier I incident reports make recommendations on whether there is a need for a more in-depth Tier II analyses based on high frequency and/or severity of incidents in IDS, SENSOR-Pesticides, and the preliminary Agricultural Health Study results for a particular active ingredient. If a recommendation for further in-depth analyses (Tier II) is made, a broader set of available incident data sets are reviewed and a review of available epidemiological studies and

human toxicology and medical case reports is conducted. Trend analyses and summaries (root cause analysis) with respect to incidents is done, as well as additional analysis on a product-specific (as opposed to active ingredient) basis.

This Tier II glyphosate analysis includes human observation data from a variety of sources including:

- Human toxicological reviews and medical case reports from the literature,
- Human incident (poisoning) data from such sources as OPP's Incident Data System (IDS) database, NIOSH SENSOR, the Agency-sponsored National Pesticide Information Center (NPIC), California's Pesticide Incident Surveillance Program (PISP), American Association of Poison Control Centers (AAPCC) Annual Reports, and
- Epidemiological studies from the literature.

2. MEDICAL CASE REPORTS

a. Literature Search Methodology

While much animal toxicology data exist and have been evaluated by OPP during the glyphosate registration review process medical data involving pesticides provide another source of information to evaluate risks of glyphosate. Medical case reports evaluate particular patients and describe the symptoms, signs, diagnosis, treatment, and follow-ups. Medical case series are similar to case reports, but focus instead on multiple patients with similar exposure, treatment and/or symptoms/signs. Case reports and case series provide insight into the potential effects of pesticide exposure on humans. It is important to remember, however, that often the exposure scenarios associated with case reports and series are high dose (suicides, attempted suicides, or non-accidental ingestions) and are dissimilar in some ways to inadvertent exposures which tends to be at substantially lower doses and with different exposure routes. Nevertheless, examining these cases can be valuable in that they illustrate the effects of frankly toxic doses and allow observation of what may be important health consequences of high-dose exposure. Medical information on pesticides are found in many locations; however the Agency has relied on information from databases for the period from 1975 to the present, querying the National Library of Medicine (PubMed, TOXNET), Web of Knowledge, Google Scholar, as well as the CDC and ATSDR databases, to identify relevant pesticide medical information. Specifically, the Agency looked across the following databases for this assessment:

- PUB MED comprises more than 22 million citations for biomedical literature from MEDLINE, life science journals and online books.
- TOXNET consists of HSDB (Hazardous Substances Data Bank) which contains comprehensive peer-reviewed toxicology data for about 5,000 chemicals.

- ATSDR Case-Studies provide information regarding clinical findings, treatment and current knowledge regarding pesticides.

- Google Scholar is a search engine that indexes the full text of scholarly literature across an array of publishing formats and disciplines. It includes most peer-reviewed online journals of Europe and America's largest scholarly publishers.

The Agency is confident that considering the above sources captures the critical medical information concerning the human health effects of glyphosate. A medical literature search on glyphosate in Pub Med, Web of Knowledge and Google was performed, using the terms (or key concepts): *glyphosate toxicity*; *glyphosate, poisoning*; *glyphosate*, *symptoms*. One hundred and ninety nine citations were recovered but many of them were not related to the human health effects of glyphosate. From the title and abstract review, animal studies with glyphosate and studies regarding environmental effects of glyphosate were removed. A Google Advanced Search and the EPA library were used to retrieve full text articles. Thirty eight full text articles related to glyphosate and human health effects, toxicokinetics, toxicodynamics and case reports were reviewed.

b. Summary of glyphosate medical literature review.

Glyphosate [N-(phosphonomethyl)glycine] is a nonselective herbicide. Glyphosate inhibits the enzyme 5-enolpyruvyl-shikimic-3-phosphate-synthase in plants; however, mammals do not have this enzyme (Aaron, 2006). Glyphosate should thus possess low risk for mammalian toxicity. Glyphosate has been placed in Toxicity Category III for oral and dermal acute toxicity (i.e. oral LD_{50} 500 – 5,000 mg/kg), which means low acute toxicity for oral, and dermal exposures. It is a mild eye irritant and is not a dermal sensitizer. In addition, neurotoxicity was not observed in any of the acute, subchronic, chronic, developmental or reproductive animal studies performed with glyphosate (D398547, 11/14/2012, T. Bloem et al.).

However, glyphosate end products (commercial products) are usually formulated with different glyphosate salts with various concentrations of surfactant polyoxyethyleneamine (POEA) up to 50% and other ingredients (antifoaming agents, biocides and inorganic ions), rather than active ingredient glyphosate alone. For example, Roundup contains 41% glyphosate as the isopropylamine salt and 15% POEA. This can potentially make the end product more toxic than the active ingredient alone.

There have been many reports in the medical literature on acute poisoning with commercial glyphosate –based formulations. Most of the accidental ingestions of glyphosate formulations resulted in mild symptoms such as irritation of oral and upper gastrointestinal mucosa and were self limited. However, intentional ingestions caused moderate to severe symptoms in multiple organs. It was reported that most of these symptoms may actually be related to the surfactant polyoxyethyleneamine (POEA) or other ingredients in the commercial glyphosate formulations

(Bradberry, Proudfoot, & Vale, 2004; Sawada, Nagai, Ueyama, & Yamamoto, 1988). Since human poisoning with this herbicide is not with the active ingredient (glyphosate) alone but with various mixtures, it is not easy to identify the exact cause. Table A in Appendix 1 identifies various glyphosate product formulations that have been previously identified by the U.S. Forest Service (Diamond & Durkin, 2011).

Experimental studies have found that the toxicity of a surfactant (POEA) is greater than the toxicity of glyphosate alone (Bradberry et al., 2004; Peixoto, 2005). Hour B.T. et al. (2012) also reported that surfactants interfere with the proton gradient in the mitochondria wall, affecting energy production in cells leading to cell death. According to Peixoto F. (2005), Roundup interferes with electron transfer by partially inhibiting mitochondrial complexes II and III, leading to depressed ATPase activity. When the authors used the glyphosate alone in the same concentration they did not find this effect. Diamond (2011) mentioned that there were various concentrations of POEA surfactant, glyphosate salts and other ingredients in different glyphosate products and the resulting adverse health effects may be different. The adverse health effects of accidental and intentional exposures to glyphosate products are summarized from medical case reports in the following sections.

c. Summary of Case Reports

Various case reports are summarized in this section, and are divided into accidental/unintentional exposures and intentional exposures.

i. Accidental/Unintentional Exposures

Inhalation Exposure:

- Ptok M., (2009) reported that a 26-year-old school teacher suffered from a severe dysphonia (abnormal vocal sounds) a few hours after applying glyphosate product (more detailed information regarding the exposure was not available). She informed that she had followed the instructions on the product label. A laryngoscopy found decreased vocal fold mobility. The symptoms disappeared spontaneously and her vocal fold mobility returned to normal after 6 weeks (Ptok, 2009).
- A 42 year old worker exposed to Roundup suffered from burns in the mucosal lining of the pharynx and larynx and acute toxic pneumonitis (inflammation of lung tissue) (Pushnoy, Avnon, & Carel, 1998). He presented at the ER with shortness of breath, irritative cough, dizziness, discomfort in the throat and episodes of hemoptysis (blood in the sputum). According to the patient he developed these symptoms after cleaning the clogged sprayer containing Roundup inside a small room. His chest X-ray (Figure 1) showed extensive bilateral alveolar involvement. The authors stated that the surfactant

polyoxyethylene amine is the main reason for erosion of upper respiratory tract mucosal lining and lung tissue.

Figure 1. Chest radiograph

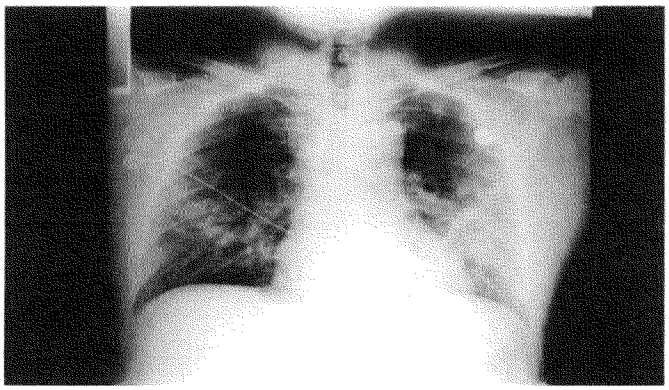


FIGURE 1. Chest radiograph on admission demonstrating interstitial bilateral infiltrations.

Dermal Exposure:

Although glyphosate alone has been found to have low dermal toxicity, there were several cases of severe dermal effects due to accidental exposure to formulations containing glyphosate and surfactants.

- Amerio et al. (2004) reported that a 78 year old woman presented with extensive chemical burns on her back, knees and legs caused by an accidental contact with a glyphosate-surfactant formulation (41% glyphosate and 15% POEA). She knelt on the ground where her son had just sprayed the herbicide. Later she put on clothing that had been lying on the same ground contaminated with the herbicide. At home, she lay down in the same clothing on the couch. After several hours she noticed burning sensation on areas that had been in touch with the glyphosate product; and sheets of necrotic epidermis (dead skin) had sloughed, causing extensive erosions. Fluid filled lesions (bullae) were also appeared on the dorsum of the feet. She was treated with normal saline wet dressing, petrolatum gauze, topical hydrocortisone 1% plus silver-sulfadiazine cream, and systemic antibiotic piperacilline/tazobactam (to prevent secondary infection). It took four weeks to heal these skin lesions. The authors mentioned that effects of glyphosate on human skin depend on several factors, such as concentration of glyphosate in the formulation, the duration of exposure, the presence of a surfactant in the formulation, and skin conditions such as moisture, sweat, and the presence of sebum (Amerio et al., 2004).

- Mariager et al. (2013) also described a 43-year old man with severe chemical burns following prolonged accidental exposure to the herbicide Roundup Bio (isopropylamine salt of glyphosate and surfactant POEA with the pH of 4.5-5). The contents accidentally

sprayed on the patient when he shook the bottle. He did not wash the exposed areas for more than 24 hours. The next day he developed local swelling, bullae and exuding wounds on his left hand, arm, upper arm and axilla regions. Soon it changed into second degree skin necrosis with detachment of the epidermis. In addition, he had touched his face with contaminated hands resulting in swelling of the area around the eye. After three months, nerve conduction studies showed reduced nerve conduction in distal axons on the medial, ulnar and radial nerves in the exposed hand. Hand X-ray done after 4 months revealed osteopenia of carpal bones. After 9 months, the patient regained near normal sensation but he had severe atrophy of the intrinsic muscles of the hand and loss of strength with decreased range of motion. All other skin lesions had healed with scarring and alopecia (hair loss), (Figures 2, 3 and 4) (Mariager, Madsen, Ebbehoj, Schmidt, & Juhl, 2013).

Figure 2: Atrophy of hand muscles resulting in deformity (Mariager TP., et al.)

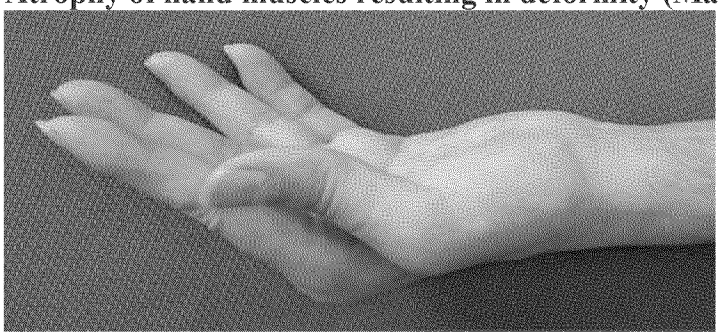
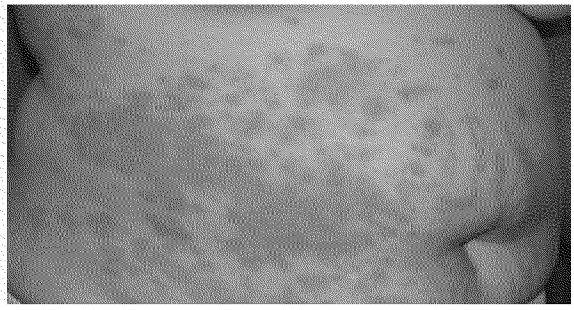


Figure 3: Osteopenia of the carpal bones (Mariager TP., et al.)

Figure 4: Chemical burn healing with alopecia (Mariager TP., et al.)

- Another dermal exposure involved a 37 year old female. She was exposed to glyphosate herbicide (Touchdown Premium) when the backpack containing the herbicide broke and wet her clothing. The herbicide contained 36% glyphosate ammonium salt which she diluted with water before using it. She admitted delaying in rinsing off the herbicide. At the end of the day she suffered from the irritant contact dermatitis, followed by erythemato-purpuric plaques developed on the upper extremities, on the abdomen, axilla and groin (Figure 5). The patient was treated with oral corticosteroids and antihistamines. The lesions got better in 2 weeks with post-inflammatory hyperpigmentation (Heras-Mendaza, Casado-Farinas, Paredes-Gascon, & Conde-Salazar, 2008).

Figure 5: Erythematous and purpuric plaques on the abdomen (Heras-Mendaza F., et al. 2008)



- Fisher KR., et al (2008) reported a patient who developed pemphigus vulgaris (PV) on his body and extremities, after an occupational exposure to fumes of burning empty glyphosate drums. PV is an autoimmune skin lesions characterized by bullae that rupture quickly and progress to crusted erosions. Authors mentioned that their patient had been using glyphosate product with 41% glyphosate isopropylamine salt on the farm for the past 3 years, which might have sensitized the skin (Figure 6) (Fisher et al., 2008).

Figure 6: Scattered bullae and vesicles on the body (Fisher KR., et al., 2008)

Accidental death with glyphosate trimesium formulation (Touchdown):

- Sorensen et al. (1999) reported an accidental ingestion of Touchdown causing the death of a 6-year-old boy. He accidentally ingested a mouthful of the herbicide and died within a couple of hours. His father had placed the bottle containing the herbicide on the table in the garage and the child mistook it for a drink. The child spat almost all of it out and swallowed only a small amount because of the bad taste. He then went into the house and drank some water. Soon he developed pain, vomiting, and then collapsed. The father performed cardiopulmonary resuscitation (CPR) when he noticed that his son was not breathing and had no pulse. The child was taken to the hospital and, in spite of the resuscitation attempt, he passed away. The post-mortem examination revealed edema of the mucus membranes of the airways, erosion of the mucus membranes of the gastrointestinal tract, pulmonary edema, cerebral edema, and dilated right atrium and ventricle of the heart (Sorensen & Gregersen, 1999).

ii. Intentional Exposures

Intentional exposure or suicide cases can assist in understanding the relative sensitivity of humans to the toxicity of glyphosate formulations. Some of the case reports may be used for estimating the acute lethal toxicity of glyphosate-surfactant formulations.

- Bradberry et al. (2004) reported that ingestion of >85 mL of the concentrated formulation can cause serious toxicity in adults. Pain in mouth, throat, stomach and dysphagia (difficulty in swallowing) due to gastrointestinal corrosion are common. In severe cases, pulmonary edema (fluid inside the lung), respiratory distress, cardiac arrhythmias (abnormal heart rhythm), shock, and impaired consciousness may occur. In addition, renal failure, metabolic acidosis and hyperkalemia (high serum potassium level) may take place requiring hemodialysis for treatment (Bradberry et al., 2004).

- Zouaoui et al. (2013) reviewed 13 cases of glyphosate herbicide intentional poisoning, and found that the most common symptoms were oropharyngeal ulcerations, nausea and vomiting. The main biochemical abnormality was lactic acidosis. Other adverse health effects were: respiratory distress; cardiac arrhythmia; hyperkalemia; impaired renal function; liver toxicity; and altered consciousness. In mild to moderate intoxications, blood glyphosate concentrations were in the range of (0.6 – 150) mg/L with a mean value of 61 mg/L. In the severe intoxication case, the blood glyphosate concentration was found at 838 mg/L; and in fatal cases the range of (690-7480) mg/L with a mean value of 4146 mg/L was found (Zouaoui, Dulaurent, Gaulier, Moesch, & Lachatre, 2013).

- Chang CY., et al., (1999) studied lesions in gastrointestinal tract of 50 patients with glyphosate-surfactant oral ingestion as a suicide attempt. They found that esophageal injury was seen in 68% of the patients (15% grade 1, 15% grade 2a and 4% grade 2b); gastric injury in 72% (22% grade 1 and 8% grade 2a), and duodenal injury in 16% (7% grade 1 and 1% grade 2a). [According to the Zargar's modified grading system, Grade 1 injuries have swelling and redness of mucosa. Grade 2a injuries have friability, hemorrhage, erosion, blistering, whitish membranes, exudates or superficial ulcerations. Grade 2b injuries have features of grade 2a plus circumferential ulcerations] (C. Y. Chang et al., 1999). Chen HH., et al., (2013) stated that patients with grade 2b esophageal injury suffered from a greater incidence of respiratory (100.0% versus 5.9%, $P = 0.001$) and gastrointestinal (66.7% versus 11.8%, $P = 0.034$) complications than patients with grade 1 injury (H. H. Chen et al., 2013).

- Talbot and Shiaw (1991) reviewed 93 cases of exposure to Roundup from 1980 to 1989. They found that the lethal cases had ingested glyphosate herbicide (41% solution), ranging from 85-200 mL. These patients had: erosion of gastrointestinal tract (66%); sore throat (43%); dysphagia (31%): and gastrointestinal hemorrhage (8%). Other organs involved were: non-specific leucocytosis in blood (65%); pulmonary edema (23%); liver dysfunction (19%); cardiovascular shock (18%); kidney dysfunction (14%); and central nervous system (changes in the level of consciousness) (12%) (Talbot et al., 1991).

- A case-control study conducted by Lee C.H. et al., (2008) and a retrospective study done by Lee H.L. et al., (2000) found similar multi-organ effects. Author's found that useful indicators for predicting serious outcome from commercial glyphosate product were: metabolic acidosis; hyperkalemia; respiratory distress requiring intubation; tachycardia; and elevated serum creatinine levels. According to authors, pulmonary toxicity and renal toxicity were mostly responsible for the fatality (C. H. Lee, Shih, Hsu, Hung, & Lin, 2008; H. L. Lee, Chen, Chi, Huang, & Tsai, 2000).

- Kamijo Y. et al. (2012) and Bando H. et al. (2010) reported that ingestion of Roundup Maxload (48% glyphosate potassium salt) can cause severe hyperkalemia and severe complications (Bando et al., 2010; Kamijo, Mekari, Yoshimura, Kan'o, & Soma, 2012). A 69- year old female had serum potassium levels of 10.7 mEq/L (normal range is 3.5 – 5 mEq/L), loss of consciousness, low blood pressure, metabolic acidosis and abnormal cardiac rhythm (ventricular tachycardia) after ingesting about 500 mL of Roundup Maxload. Serum glyphosate levels on admission and after 20 hours were 1625.74 and 100.44 µg/mL, respectively. Chest X-rays showed diffuse pulmonary infiltrate. The endoscopy showed pharyngeal edema, esophageal erosions, and gastric erosions. Patient was given activated charcoal and put on cardiopulmonary support, continuous hemodialysis, and mechanical ventilation. Although the patient recovered, the authors reminded that glyphosate products containing high potassium that can be easily purchased in retail stores possess a serious problem in Japan.

- Stella J. and Ryan M. (2004) stated that the triad of pulmonary edema, metabolic acidosis, and hyperkalemia indicates a poor outcome, and may not respond to even the most intensive supportive care (Stella & Ryan, 2004).

- Chang CB., et al. (2009) also reported that a 57-year old woman who ingested 400 ml of a Taiwanese glyphosate formulation (41% glyphosate isopropylamine and 15% polyoxyethyleneamine) died in spite of intensive treatment. On admission to the hospital, the patient was drowsy although vital signs were within the normal range. Shock and respiratory failure developed within 5 hours after admission to the hospital. She was transferred to the intensive care unit, put on the mechanical ventilator, and treated according to the critical care procedures. The hyperkalemia was corrected with insulin/glucose infusion and oral kayexalate. The acidosis was corrected by intermittent sodium bicarbonate infusions. However, refractory shock persisted despite the administration of fluids, dopamine, vasopressin, epinephrine, and norepinephrine. Ventricular tachycardia developed on the third day of admission and the patient died (C. B. Chang & Chang, 2009).

- Although animal studies found that absorption of glyphosate from the stomach is inefficient, Roberts DM., et al. (2010) stated that in humans, commercial glyphosate solution is rapidly absorbed from the GI tract, and followed first-order elimination with a half-life ranged from (2.7-3.6) hours. This reflects the rapid development of adverse health effects in humans (Roberts et al., 2010).

- Sribanditmongkol P., et al. (2012) reviewed the pathological and toxicological results of a fatal poisoning case. The postmortem examination of a 37-year old woman who ingested 500 mL of concentrated Roundup formulation (41% glyphosate as the

isopropylamine salt and 15% polyoxyethylene amine) revealed hemorrhagic areas in the gastric mucosa and marked dilatation and thin walls in the small intestines. A mild degree of pulmonary congestion and edema was observed in both lungs. The glyphosate level in the serum was 3.05 mg/mL; the glyphosate level in the gastric contents was 59.72 mg/mL (Sribanditmongkol, Jutavijittum, Pongraveevongsa, Wunnapuk, & Durongkadech, 2012).

- According to Wu J.Y. (2006), intravenous injection of 250 mL of diluted glyphosate (150 mL of glyphosate in 500 mL of water) in a suicide attempt caused acute hemolysis (rupturing red blood cells inside the blood vessels) in a 22-year-old male patient (Wu, Chang, Tseng, Deng, & Lee, 2006).

iii. Direct Renal Toxicity

- Yoo et al. (2009) found that the product (41% glyphosate with surfactant) can cause direct toxic effects on kidneys. Their patient had suffered from the severe tubulointerstitial nephritis without the cardiovascular collapse which means that the renal insufficiency in this case was not secondary to the low blood pressure and poor renal perfusion, but due to direct toxic effect of glyphosate product on kidneys. He was admitted to the hospital 30 minutes after ingesting 90 mL of glyphosate herbicide. On arrival, his serum creatinine was normal (0.8 mg/dL) and other laboratory findings including liver, cardiac, and muscle enzymes were within normal ranges. Two days after admission, although his vital signs were stable, his serum creatinine abruptly increased to 8.2 mg/dL and oliguria (very low urine output due to renal insufficiency) developed. The kidney biopsy also showed the chemical/glyphosate-induced nephrotoxic injury. He was treated with hemodialysis and two weeks later, his renal function started to improve slowly (Yoo & BS., 2010).

iv. Neurotoxicity

Although neurotoxicity was not observed in any of the acute, subchronic, chronic, developmental or reproductive animal studies performed with the glyphosate, there were few case reports with central nervous system effects suggesting direct neuronal toxic effects from the glyphosate-surfactant herbicide (GlySH).

- Malhotra et al. (2010) reported that a 71-year-old male who attempted suicide with the commercial glyphosate formulation developed a prolonged (>7days) but reversible encephalopathy. He also had cardiogenic shock and severe metabolic acidosis (pH 7.13; HCO_3 13.2 mmol/L). His blood acetylcholinesterase level was within normal range. Authors mentioned that although glyphosate has a carbon and phosphorus moiety it does not inhibit acetylcholinesterase enzyme unlike organophosphate pesticides. The EEG (electroencephalogram) indicated encephalopathy. He was treated in the intensive care

unit and also received hemodialysis. He fully recovered after 15 days in the hospital (Malhotra, Ghia, Cordato, & Beran, 2010).

- A case of aseptic meningitis after ingestion of about 150 mL of commercial glyphosate herbicide (41% glyphosate and 15% polyoxyethyleneamine) was reported by Sato C et al. (2011). A 58 year-old female presented with signs and symptoms of meningitis such as neck stiffness, rigidity of limbs, Kernig's sign (severe stiffness of the hamstring muscle causing an inability to straighten the leg when the hip is flexed to 90 degrees), and altered consciousness. All bacteriological and virological tests were negative. Glyphosate level in the cerebrospinal fluid (CSF) was 122.5 μg/ml. Authors mentioned that signs and symptoms of meningitis decreased as the concentration of glyphosate in CSF decreased. She completely recovered after 39 days due to the aggressive supportive care in the intensive care unit. The authors determined that the findings were suggestive of aseptic meningitis caused by the commercial glyphosate poisoning (Sato, Kamijo, Yoshimura, & Ide, 2011).

- Potrebic et al. (2009) described the neurologic lesion of a 56-year old woman who ingested about 500 mL of herbicide containing glyphosate isopropylamine salt. She suffered from hypotension, hyperkalemia, respiratory and renal failure and fell into a coma. Although the patient received the intensive care, she did not regain consciousness. An MRI revealed bilateral extensive white matter lesions of the brain stem and Pons (Potrebic, Jovic-Stosic, Vucinic, Tadic, & Radulac, 2009).

- Wang G., et al (2011) reported that a previously healthy 44 year-old woman presented with rigidity, slowness and resting tremor (typical of Parkinsonism) in all four limbs. She had worked exclusively at the glyphosate production division for 3 years while wearing only basic personal protective equipment (PPE) (gloves or face mask) for 50 hours a week. The MRI revealed bilateral hypotense lesions in the globus pallidus, the substantia nigra, and in the cerebral peduncle of the brain. Authors stated that the patient's occupational history and MRI results indicated a secondary Parkinsonism due to glyphosate product, rather that primary idiopathic Parkinson's disease (G. Wang, Fan, Tan, Cheng, & Chen, 2011).

v. Determination of blood glyphosate level and urine level of metabolite

Serum glyphosate and its metabolite aminomethyl phosphonic acid (AMPA) in urine can be determined by gas chromatography-mass spectrometry (GC-MS) (Hori, Fujisawa, Shimada, & Hirose, 2003; Motojyuku et al., 2008). Wang Y., et al., 2012 reported that ion chromatography is a simple, sensitive and accurate method to prove that the patient had a glyphosate poisoning (Y. Wang, Wu, Lian, & Shi, 2012).

d. Conclusion

Although animal studies showed glyphosate to have limited toxicity, medical case reports suggest that glyphosate end use products (formulated with, different types of glyphosate salts and various concentrations of surfactants and adjuvants), may be more toxic than the active ingredient alone. Since human poisoning reviewed were not with the active ingredient (glyphosate) alone but with various mixtures, it is not easy to identify the exact cause. Nevertheless, the medical literature reviewed indicates that most of the accidental ingestions of glyphosate formulations resulted in mild symptoms such as irritation of oral and upper gastrointestinal mucosa and were self limited. However, intentional ingestions caused moderate to severe symptoms in multiple organs.

3. HUMAN INCIDENT DATA

As indicated above, incident information can provide important feedback to the Agency, assisting in determining actual real-world exposures and risks posed by pesticides/pesticide products. Incident data are collected systematically, but differently, across the different databases used by the Agency with respect to such issues as coverage, certainty/confidence, fields/parameters reported, and usability. The aforementioned five pesticide incident data sources (IDS, NPIC, AAPCC, California PISP, and NIOSH/SENSOR) were used in this glyphosate report since they provide useful content and historical perspective. Various other comparable sources of data are available (e.g. the Bureau of Labor Statistics, emergency room outpatient surveillance, National Poison Data System (NPDS), etc.) but are not included in this review. By looking across the five data sources which were used, the Agency is confident that we are considering adequate and appropriate information to discern trends and patterns in glyphosate-associated acute pesticide poisonings, or "incidents."

a. OPP Incident Data System (IDS) (2008-2013)

The OPP IDS includes reports of alleged human health incidents from various sources, including mandatory Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) Section 6 (a) (2) reports from registrants and reports from other federal and state health and environmental agencies and individual consumers. Since 1992, OPP has compiled these reports in IDS. IDS contain reports from across the U.S. and most incidents contained in the system have all relevant product information recorded. Case reports or "narratives" are provided for each incident, with varying levels of detail; however, there is no effort at validating or assessing how likely it is that the reported exposure is causally related to the reported outcome. Because IDS has such extensive coverage, it is useful for providing temporal trend and geographic pattern information. The system is also useful for determining whether risk mitigation has helped reduce potential pesticide exposure through a decreased number of reported incidents.

For this evaluation, the OPP IDS was utilized for pesticide incident data on the active ingredient glyphosate (PC Codes 103601, 103603, 103604, 103605, 103607, 103608, 103613, and 417300). The incident data system records incidents in one of two modules: Main IDS and Aggregate IDS. Main IDS contains incidents resulting in higher severity outcomes and provides more detail with regard to case specifics. This system stores incident data for death, major and moderate incidents, and it includes information about the location, date and nature of the incident. Main IDS incidents involving only one active ingredient (as opposed to pesticide products with multiple active ingredients) are considered to provide more certain information about the potential effects of exposure from the pesticide. The higher severity outcomes include:

- H-A (death): If the person died;
- H-B (major): If the person alleged or exhibited symptoms which may have been life-threatening, or resulted in adverse reproductive effects or in residual disability; and
- H-C (moderate): If the person alleged or exhibited symptoms more pronounced, more prolonged or of a more systemic nature than minor symptoms, usually some form of treatment of the person would have been indicated, symptoms were not life threatening and the person has returned to his/her pre-exposure state of health with no additional residual disability.

Aggregate IDS contains incidents resulting in less severe human incidents (minor, unknown, or no effects outcomes). These are reported by registrants only as counts in what are aggregate summaries. The less severe human incidents include:

- H-D (minor): If the person alleged or exhibited some symptoms, but they were minimally traumatic, the symptoms resolved rapidly and usually involve skin, eye or respiratory irritation; and
- H-E/H (unknown or no effects): If symptoms are unknown, unspecified or are alleged to be of a delayed or chronic nature that may appear in the future.

For the Main IDS, from January 1, 2008 to September 11, 2013, there are 502 cases reported that involve the active ingredient glyphosate. Of these 502 cases, there are 212 cases reported for the single chemical glyphosate in the database that occurred in the United States.[1] Summaries of these incidents are recorded in Appendix A. There was one death due to suicide, 6 suicide attempts, 2 suspected suicide attempts, and three malicious intent incidents which were not reviewed further for symptoms and are not included in the severity totals. There were also two incidents reported as lawsuits to IDS that were not considered in this report.

In addition to the suicide, there were two deaths reported. Upon further review these two reported deaths cannot be substantiated as being related to glyphosate. In one case, the death

[1] There were 16 events reported that occurred outside of the United States (5-Canada, 5-Brazil, 2-Argentina, 1-United Kingdom, 1-Jamaica, 1-Malawi, 1-Mozambique) that were not reviewed. Foreign incidents are not reviewed in detail because of the potential differences in the exposure patterns, use practices, and product formulation.

was reported by a third party with no further details. In the other case, a woman reported her husband and a neighbor both died of tumors. She reports that both she (major severity) and her husband (death) were exposed to Roundup three years before, and both developed tumors; however, the exposure to Roundup is unclear in the incident report.

One hundred and ninety nine cases were reviewed further for severity, exposure scenario, and reported symptoms. Nine of these incidents classified as majors; 185 incidents were classified as moderates; 2 incidents were classified as minor and 1 was classified as no effects. [2] The nine major severity incidents mostly involved applicators (4 were home owner mixer/loader/applicator and 2 were applicators (unknown if home or agricultural), 1 is nonagricultural occupational exposure and 2 are unknown exposure scenario.

Homeowner mixing/loading and/or applying resulted in the most (46%) reported exposures (most of these incidents occurred due to leaks, spills, splashes, mist and product blowback during mixing loading or applying (n=46), or equipment malfunction (n=12)) followed by post application exposure (14%). There were 9 exposures to children ages 11 years old and younger. These children were exposed through post application exposure or due tampering with the product, or accidental exposure. A summary the exposure scenario counts reported to Main IDS is provided in Table 1. The incident narratives for these incidents are provided in Appendix 2.

Table 1. Exposure Scenario Frequency of incidents reported to Main IDS (2008-2013)

Exposure Scenario	Number of reported incidents (%)
Home owner mixer/loader/applicator	90 (46)
Post application exposure	27 (14)
Unknown	20 (10)
Applicator exposure (unknown if homeowner of occupational)	17 (9)
Drift	12 (6)
Child exposures	9 (5)
Occupational application exposure	6 (3)
Accidental ingestions (adult)	5 (3)
Dermal contact (not applying)	4 (2)
Ingestion of treated fruit	2 (1)
Occupational mixing/loading	2 (1)
Non-agricultural occupational exposure	1 (0.5)
Smoked product in marijuana	1 (0.5)
Indoor use	1 (0.5)
Total	197[a]
[a]This total does not include the two death incidents which are described above.	

[2] Minor severity incidents and "no effects" incidents are typically reported to the Aggregate IDS, but do occasionally get reported to the Main IDS. For glyphosate, there are 6054 more minor severity incidents and 89 incidents with no or unknown effects reported to Aggregate IDS.

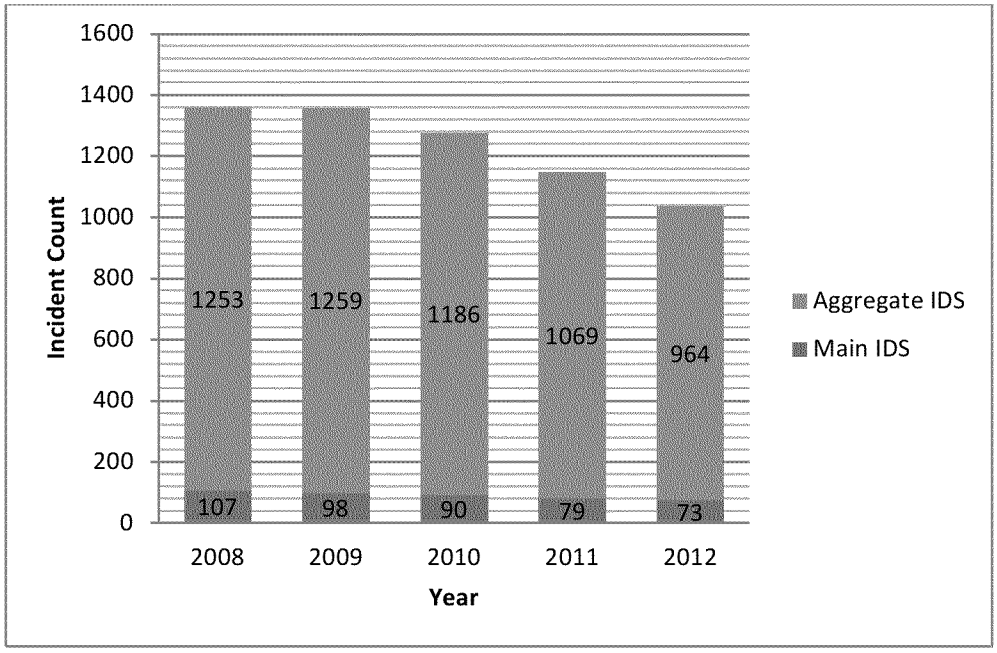
Based on the IDS reports, symptoms most often reported were dermal (n=72), neurological (n=70), respiratory (n=37), ocular (n=27), gastrointestinal (n=24), and cardiovascular (n=7). Note that a patient could exhibit multiple symptoms. Dermal symptoms reported include hives, swelling, rash, burning sensation, blotches, redness, peeling skin, and itchiness. Neurological symptoms reported include shaking, muscle cramps, diaphoresis, headaches, paresthesia, ataxia, disorientation, and dizziness. Respiratory symptoms reported included wheezing, coughing, sinus infection, nasal discharge, sore throat, and shortness of breath. Ocular symptoms reported were burning eyes, eye irritation and swelling, eye redness, foreign body sensation and vision problems. Gastrointestinal symptoms reported were nausea, diarrhea, vomiting, and abdominal pain. Cardiovascular symptoms reported include low blood pressure, chest tightness, chest pain, and heart attack.

In Aggregate IDS, queried from January 1, 2008 to May 8, 2013, there are 6143 incidents involving glyphosate. Because it falls within the categories reported as counts (which includes minor, unknown or no effects), there is no unique report that provides details about the incident and single chemical incidents are not distinguished from multiple chemical incidents; however, in general a high frequency of incidents indicates there is a high potential for exposure or elevated acute toxicity and vice versa.

Most (92%) of the incidents reported to IDS involving glyphosate were either minor severity (n=6054) or no or unknown effects (n=89). For the minor incidents, this means that a person alleged or exhibited some symptoms, but they were minimally traumatic, the symptoms resolved rapidly and usually involved skin, eye or respiratory irritation. For the no/unknown effects, this mean that symptoms are unknown, unspecified or are alleged to be of delayed or chronic nature that may appear in the future.

The glyphosate incidents trend over time, from 2008 to 2012, was reviewed. The number of reported incidents appears to have decreased since 2008 (Figure 7).

Figure 7. Number of Glyphosate Incident per Year (2008 to 2012) Reported to IDS



The most often implicated glyphosate products in Main IDS are:

- Honcho Herbicide (Reg. No. 524-445) (n=88)
- Roundup Weed & Grass Killer Ready-To-Use Poison Ivy and Tough Brush Killer (Reg. No. 71995-23) (n=20)
- Roundup Weed & Grass Killer Ready-To-Use (Reg. No. 71995-32) (n=19).

In Aggregate IDS the main often implicated products are:

- Roundup Weed & Grass Killer Ready-To-Use Plus (Reg No. 71995-33) (n=1397)
- Roundup Weed & Grass Killer Concentrate Plus (Reg. No. 71995-29) (n=746)
- Roundup Herbicide (Reg. No. 524-445) (n=628)
- Roundup Weed & Grass Killer Ready-To-Use Poison Ivy and Tough Brush Killer (Reg. No. 71995-23) (n=390), and
- Roundup Weed & Grass Killer Ready-To-Use (Reg. No. 71995-32) (n=341).

Roundup Weed & Grass Killer Ready-To-Use Plus (Reg No. 71995-33) was implicated the most often in IDS (n=1397). This product is used to kill weeds and grasses in places, such as on patios, walkways, and driveways, (gravel, or mulch beds) in flower beds and vegetable gardens, around shrubs and trees, along fences and foundations. This is likely due to the high volume of use of this product. All the resulting incidents are minor severity.

b. National Pesticide Information Center (NPIC) (2007-2013)

The National Pesticide Information Center or NPIC is a cooperative effort between Oregon State University and EPA which is funded by EPA to serve as a source of objective, science-based pesticide information and respond to inquiries from the public and to incidents. NPIC functions nationally during weekday business hours through a toll-free telephone number in addition to the internet (www.npic.orst.edu) and email. Similar to Poison Control Centers, NPIC's primary purpose is not to collect incident data, but rather to provide information to inquirers on a wide range of pesticide topics, and direct callers for pesticide incident investigation and emergency treatment. Nevertheless NPIC does collect information about incidents (approximately 4000 incidents per year) from inquirers and records that information in a database. NPIC is a source of national incident information but generally receives fewer reports than IDS. Regardless, if a high frequency is observed in IDS, NPIC provides an additional source of information to see whether there is evidence of consistency across national data sets or possibly duplication and additional information about the same incident(s).

From 2007 to July 2013, 173 glyphosate incidents were reported to NPIC. NPIC estimates a certainty index as to whether an incident (including reported symptoms) was either definitely, probably, possibly, or unlikely to have been caused by the reported exposure to a pesticide, or whether the incident was unrelated to pesticides or if the incident was unclassifiable. Of the 173 reported incidents, 34 were reported as symptomatic and classified as definitely, probably, or possibly related to the glyphosate exposure and 55 cases were unclassifiable. Of these 55 unclassifiable cases, 53 were asymptomatic and 2 were reported as unknown symptoms. Of the 173 reported incidents, 82 were classified by NPIC as unlikely to have been caused by glyphosate. There were two suicide attempts which were not further reviewed. The Agency further reviewed the 89 incidents that were classified as definite, probable, possible and unclassifiable.

Of the 89 reported incidents reviewed by the Agency, homeowner mixing/loading and/or applying resulted in the most (n=42) reported exposures. Of these 42 exposures, most (n=26) occurred due to leaks, spills, splashes and product blowback during mixing loading or applying, or (n=11) equipment malfunction. Of the 89 reviewed incidents, the next most reported exposures were due to childrens exposures and drift (both 19%). A summary of the exposure scenario counts reported to NPIC is provided in Table 2.

Table 2. Exposure Scenario Frequency of Incident Reported to NPIC (2007-2013)

Exposure Scenario	Number of reported incidents (%)
Home owner mixer/loader/applicator	42 (47%)
Child exposures	15 (19%)
Drift	15 (19%)
Dermal contact (not applying)	6 (7%)
Occupational applicator	4 (4%)
Homeowner post application exposure	3 (3%)
Adult accidental ingestion	2 (2%)
Ate treated food from garden	1 (1%)
Unknown exposure	1 (1%)
Total	89

The symptoms most often reported to NPIC were respiratory (n=11), ocular (n=11), neurological (n=9), dermal (n=8), and gastrointestinal (n=5). Note that a patient could exhibit multiple symptoms. Respiratory symptoms reported included difficulty breathing, nasal discharge, nose irritation, and throat irritation. Ocular symptoms reported were red and irritated eyes, burning eyes, stinging eyes, blurry vision. Neurological symptoms reported include headaches, loss of balance, altered taste, dizziness, and Paresthesia. Dermal symptoms reported include rash, burning sensation, and redness. Gastrointestinal symptoms reported were nausea, diarrhea, and vomiting.

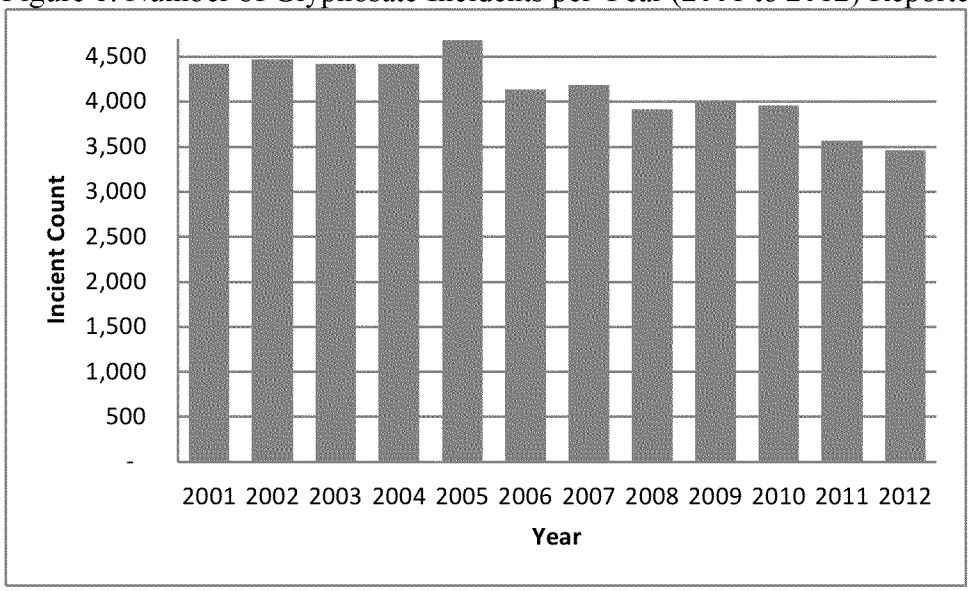
c. American Association of Poison Control Centers (2001-2012)

The American Association of Poison Control Centers (AAPCC) is a non-profit, national organization founded in 1958 that represents the poison control centers of the United States and the interests of poison prevention and treatment of poisoning. All of the calls to a poison control center are managed by a medical professional trained to answer questions about poisons. Additionally, AAPCC reports provide clearly summarized information on pesticide incidents within the context of other poisoning events.

AAPCC produces an annual summary report giving statistics and information on all the poisonings reported to PCCs in a calendar year (http://www.aapcc.org/annual-reports/). Glyphosate is included in the AAPCC annual summary and Agency examined the data from 2001 to 2012. According to the AAPCC 2012 annual report, glyphosate products ranked first with 3,464 single exposures among the reported human herbicide exposures (total reported herbicide exposures were 4717). There were 3257 unintentional exposures, and 875 cases were

to children 5 years old and younger.[3] A review of the AAPCC incident trend for glyphosate from 2001 to 2012 suggests a decrease in reported glyphosate incidents from 2005 to present (Figure 8).

Figure 8. Number of Glyphosate Incidents per Year (2001 to 2012) Reported to AAPCC



d. California Pesticide Illness Surveillance Program (PISP) (2005-2010)

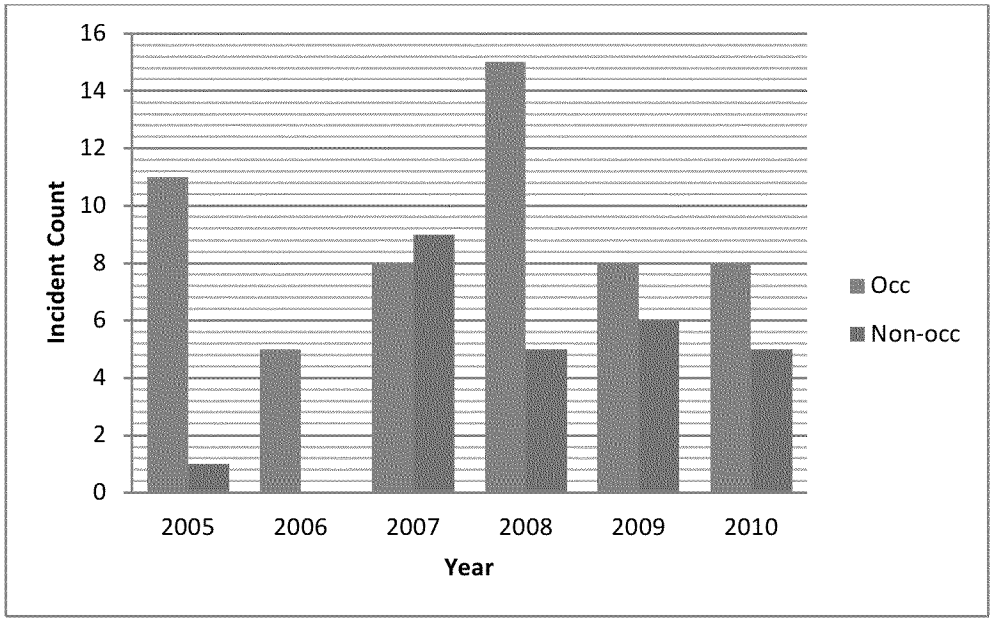
The California Pesticide Illness Surveillance Program (PISP) maintains a database of pesticide-related illnesses and injuries. Case reports are received from physicians and via workers' compensation records. The local County Agricultural Commissioner investigates circumstances of exposure. Medical records and investigative findings are then evaluated by DPR technical experts and entered into an illness registry.

PISP contains both residential and occupational pesticide incidents. PISP has limited coverage (only California) and is not particularly useful for trend over time information. However, the incident information is entered by professionals with expertise in pesticides, with extensive follow-up on each reported case so there is a high level of confidence in the information provided for each reported incident.

Eighty one cases were reported to PISP between 2005 and 2010 that involve the single reported active ingredient, glyphosate. All of these cases were classified as having a definite, probable or possible relationship with glyphosate. A total of 55 were occupational cases and 26 were non-occupational cases (Figure 9). The majority of cases (both occupational and non-occupational) occurred in a non-agricultural setting (N=56) such as landscaping or residential; 24 cases occurred in agricultural settings and in one case setting was unknown.

[3] 2012 Annual Report of the American Association of Poison Control Centers ' National Poison Data System (NPDS): 30th Annual Report
https://aapcc.s3.amazonaws.com/pdfs/annual_reports/2012_NPDS_Annual_Report.pdf

Figure 9. Number of Glyphosate Incidents per Year (2005 to 2010) Reported to PISP



The glyphosate exposure scenarios in PISP were as follows:

- 31 cases were related to the handling of application equipment, including:
    - 18 cases were related to application equipment leaks or malfunctions
    - Nine cases were related to problems while loading equipment or over-pressurizing equipment
    - Four cases involved the cleaning or repair of application equipment
    - Of these 31 equipment handling exposures, 22 cases were sprayed or splashed in the eyes or face while working with the application equipment. Eight of these cases were product handlers who were either failed to wear protective eyewear or removed their protective eyewear to load or repair the pressurized equipment and were splashed in the face and eyes (other cases may have had similar PPE issues but were not specifically cited in the report).
- Eight cases were the result of either drift (worker or bystander) or an application made while windy (exposing the handler)
- Nine cases were due to the ingestion of the product, five of which were accidental and four were intentional

- Five cases resulted from various accidents, such as vehicle problems
- Three cases involved toddlers who found the product and sprayed themselves
- Ten cases involved other various occupational exposure circumstances
- Eight cases involved other various bystander exposure circumstances
- Four cases involved other various homeowner exposure circumstances
- Three cases had unknown or unclear exposure scenarios

Symptoms Reported

Note that a patient could exhibit multiple symptoms. The most commonly reported symptom was eye irritation (n=39), followed by dermal irritation (n=37). Fourteen cases reported gastrointestinal symptoms, including vomiting, nausea, and diarrhea. Eleven cases reported respiratory symptoms including cough, wheeze, and shortness of breath. Nine cases reported a neurological symptom including headache, anxiety and dizziness. One case reported cardiovascular symptoms (Table 3).

Table 3. PISP 2005-2010: Health Effects for Glyphosate Cases

Health Effect*	Frequency
Ocular	39
Dermal	37
Gastrointestinal	14
Respiratory	11
Neurological	9
Cardiovascular	1
* Cases may report multiple health effects	

The most notable exposure pattern in the PISP data is the splashes to the eye/face during equipment handling. Appropriate PPE use, particularly protective eyewear, and equipment pressurization were important contributing factors for the glyphosate incident reports in PISP.

e. SENSOR-Pesticides (1998-2009)

The SENSOR-Pesticides database covers 11 states from 1998-2009, although reporting varies from state to state. Cases of pesticide-related illnesses are ascertained from a variety of sources, including: reports from local Poison Control Centers, state Department of Labor workers' compensation claims when reported by physicians, reports from State Departments of Agriculture, and physician reports to state Departments of Health. Although both occupational and non-occupational incidents are included in the database, SENSOR focuses on occupational pesticide incidents, and is of particular value in providing that information. A state SENSOR contact specialist attempts to follow-up with cases and obtains medical records to verify symptoms, circumstances surrounding the exposure, severity, and outcome. Using standardized protocol and case definitions derived from poison center reporting, SENSOR coordinators at State Departments of Health enter the incident interview description provided by the case, medical report, physician and patient into the SENSOR data system. The SENSOR data system is accessible to participating states and EPA.

A query of SENSOR-Pesticides 1998-2009 finds a total of 834 case reports involving glyphosate (pc codes 103601, 103603, 103604, 103605, 103607, 103608, 103613, 417300); of these, 505 involve a single active ingredient (ai). The 505 single ai cases, stemming from 495 events (no large multiple exposure events were identified), will be reviewed for this analysis. Six cases were high in severity, 57 were moderate in severity and 442 were low in severity (Table 4). Case narratives for all high and moderate severity cases are provided in Appendix 3.

Table 4. SENSOR-Pesticides 1998-2009 Glyphosate Cases by Severity (N=505)

Severity	Incident Count
Fatal	0
High	6
Moderate	57
Low	442
Total	505

Occupational and Nonoccupational[4]

- 272 cases were work-related
- 186 cases were not work-related
- 47 cases were unknown/unclear

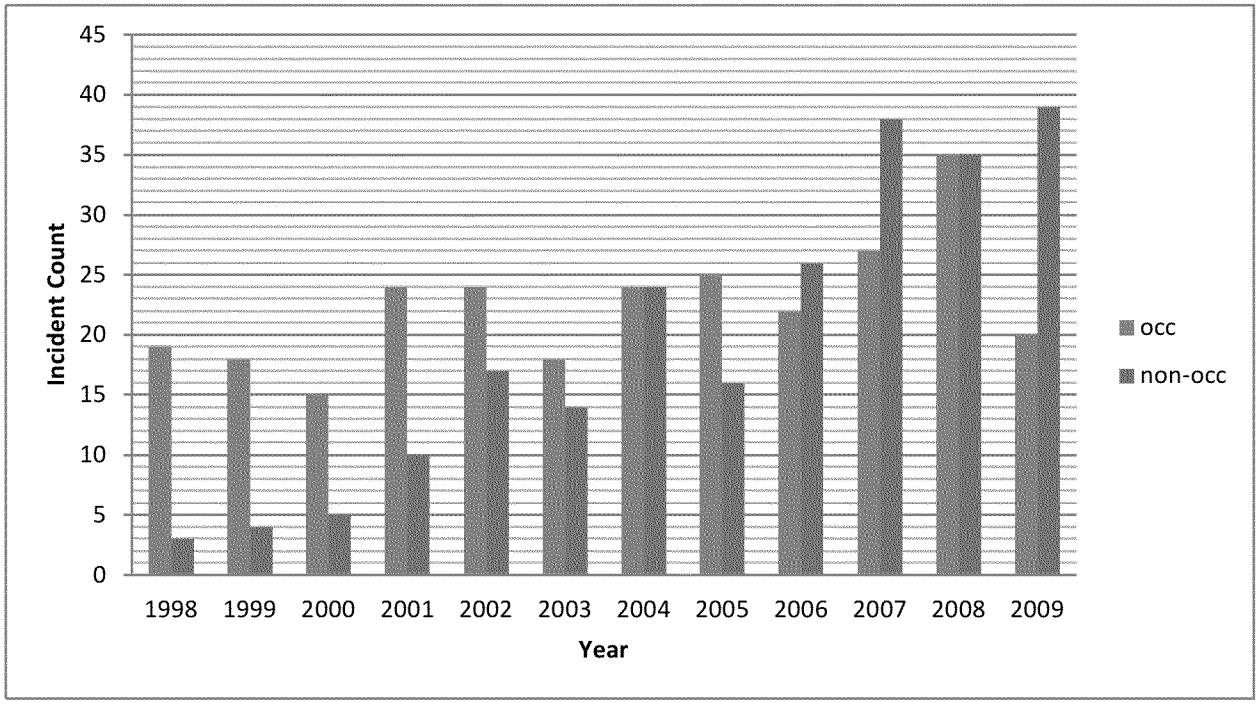
[4] SENSOR-Pesticides defines work-related cases as those illness and injuries occurring at the case's place of work.

Overall, occupational case reports involving glyphosate appeared to be increasing until 2008 and non-occupational case reports appear to be increasing over time. This trend is shown in Table 5 and the corresponding Figure 10, broken down by occupational and non-occupational case reports. The increase in non-occupational case reports may be reflective of increased SENSOR state capacity to collect non-occupational pesticide surveillance data.

Table 5. SENSOR Glyphosate Incident Count per Year (1998-2009)

Year	Occupational	Non-Occupational/ Unknown	Total
1998	19	3	22
1999	18	4	22
2000	15	5	20
2001	24	10	34
2002	24	17	41
2003	18	14	32
2004	24	24	48
2005	25	16	41
2006	22	26	48
2007	27	38	65
2008	35	35	70
2009	20	39	59
Year blank	1	2	3
Grand Total	**272**	**233**	**505**

Figure 10. Number of Glyphosate Incident per Year (1998 to 2009) Reported to SENSOR-Pesticides



Reported Symptoms

Dermal symptoms were most frequently reported (n=244) followed by ocular symptoms (n=194). The breakdown of all the symptoms are included in Table 6.

Table 6. SENSOR-Pesticides 1998-2009: Reported Health Effects for Glyphosate Cases

Health Effect*	Frequency
Dermal	244
Ocular	194
Nervous System	160
Gastrointestinal	157
Respiratory	148
Miscellaneous	48
Cardiovascular	23
Renal	5
* Cases may report multiple health effects	

Route of Exposure*
Dermal-244
Inhalation-150
Ingestion-57
Ocular-156
Unknown-32
*Case may have been exposed via multiple routes.

Multiple Exposure Events
No large multiple case exposure events were found. In Florida in 2004, four cases were exposed to Roundup after their neighbor applied it at the fence line and it subsequently drifted onto the property next door. Three were low in severity and one was moderate in severity.

Exposure Information
The most common single ai glyphosate exposure, responsible for 50% of cases, involved the application of the product. A closer review of the high and moderate severity case narratives (n=63) was conducted. Of the 63 high and moderate cases, 19 were missing case descriptions. Seventeen of the cases with missing narratives are California cases from 1998-2003. Of the remaining 44 high/moderate severity cases with case narratives provided: 16 were exposed while applying the product, eight involved equipment problems while handling the product (leaks, breaks, etc), six various exposure scenarios occurring at non-agricultural workplaces (such as landscape, Walmart), six resulted from ingestion of the product (three of these ingestion cases were high severity), four bystander exposures, two spills while mixing the product, and one child who handled the product. Among the high/moderate severity cases, ocular symptoms were most frequently reported (n=28); followed by dermal (n=25). A summary of case narratives for all moderate and high severity cases are provided in Table 7 below.

Table 7. Case Activity at Time of Exposure in SENSOR-Pesticides (1998-2009)

Code	Activity	Frequency
1	Applying	253
99	Unknown	60
10	Routine outdoor living	55
8	Routine work incl. fieldworkers	52
9	Routine indoor living	36
2	Mixing/loading	15
5	Any combination of 1-4	11
3	Transport or disposal	9
98	Not Applicable	8
4	Repair or maintenance	6
6	Manufacture or formulation	0
7	Emergency response	0
11	Application to self or another	0

Drift Cases

There were 59 glyphosate cases reported that related specifically to drift.

Child Exposures

There were 48 cases reported that involved children under the age of 18 (42 of which were 12 and under) (Tables 8 and 9). In most cases (23), children 6 years old and younger were exposed due to ingestion or tampering with the product.

Table 8. Number of reported glyphosate incidents to children in SENSOR-Pesticides

Age of Child	Incident Count
6 and under	33
7 to 12	10
13 to 17	5
Total	48

Table 9. Age 6 and under case scenarios

Exposure Scenario	Incident Count
Ingestion	12
Child Tampering with product[a]	11
Routine Application	7
Unknown	2
Spill	1
Total	33
[a]Child tampering excludes ingestion, generally involves child spraying self with product resulting in ocular or dermal exposure.	

f. Acute Glyphosate Poisoning Incident Summary

HED previously reviewed glyphosate in 2009 (*Updated Review of Glyphosate Incident Reports*, M. Hawkins and J Cordova, 03/12/2009). From the years 2002 to March 2009, 289 incidents involved products containing the single chemical glyphosate in Main IDS. HED found that "the IDS query resulted in a moderately large number of case reports which warrants searching the following databases for consistency and reproducibility of the poisoning incident data: the American Association of Poison Control Centers Toxic Exposure Surveillance System (TESS), the California Pesticide Illness Surveillance Program, and the National Institute of Occupational Safety and Health's Sentinel Event Notification System for Occupational Risks (NIOSH SENSOR)." The general findings and conclusions from HED's current review of IDS (for years 2008-2013) agree with those from this previous HED review. HED found a moderately large number of incidents reported to IDS (212 cases reported for the single chemical glyphosate in Main IDS and an additional 6143 incidents involving glyphosate in Aggregate IDS) and analyzed three additional databases and the AAPCC Annual Reports.

HED found that the acute health effects reported to the incident databases queried are consistent with the previous incident report, and the other databases and medical literature reviewed. These health effects primarily include dermal, ocular, and respiratory effects. HED did not identify any

aberrant effects outside of those anticipated. While inconvenient for those who suffer adverse health effects, effects are generally mild/minor to moderate and resolve rapidly.

The incident data available from IDS and NPIC suggest that homeowner mixing/loading/ applying (usually due to human errors and container leaks) are responsible for almost half of the reported incidents. SENSOR-Pesticides incident data are consistent with IDS and NPIC, also suggesting that application of glyphosate results in the most reported incidents (50%). However, the SENSOR-Pesticide incidents include both residential and occupational incidents. The incident data available from CA PISP suggests that occupational handling of equipment is responsible for most incidents due to equipment leaks and malfunction.

All of the databases showed the occurrence of childrens' exposures (ranging from 5% to 27% of total cases). Based on the data in SENSOR, IDS, and NPIC, it appears that the childrens' exposures are due to postapplication exposure, accidental ingestion, and tampering with the product. Ocular exposures and symptoms were reported in all of the databases, to both occupational and nonoccupational users, as a result of splash to the face or touching their eyes with the product on their hands. These symptoms primarily included eye irritation, redness, burning and blurred vision.

Trends over time data from IDS (2008 to 2012), PISP (2005 to 2010), SENSOR-Pesticides (1998 to 2009) and AAPCC (2001 to 2012) data were reviewed. Based on IDS and AAPCC, which are primarily non-occupational cases, incidents appear to be decreasing over time. CA PISP data represents both occupational and non-occupational incidents. This data appears to be relatively steady over time. The SENSOR-Pesticide data also represent both occupational and non-occupational cases. For this data, occupational case reports involving glyphosate appeared to be increasing until 2008 and non-occupational case reports appear to be increasing over time. The increase in non-occupational case reports may be reflective of increased SENSOR state capacity to collect non-occupational pesticide surveillance data.

4. CHRONIC DISEASE EPIDEMIOLOGY

In this section, HED discusses the available evidence concerning the chronic health effects of glyphosate exposure in the human population. Environmental epidemiology studies are designed to evaluate whether there is evidence of an increased (or decreased) risk of disease in relation to a specific environmental risk factor such as pesticide exposure. For this report, HED/TEB identified several published, peer reviewed epidemiology studies concerning exposure to glyphosate. A wide variety of cancer and non-cancer health outcomes are included in this analysis.

a. Literature Review Methodology

In preparing this Tier II review of environmental epidemiology data related to glyphosate exposure, HED queried publis6hed, peer-reviewed literature. Appendix 4 describes the methods reviewers utilized to identify, to select, and to evaluate the open literature studies. These methods are in accordance with the OPP Guidance on Open Literature Reviews[5]. Briefly, reviewers developed a comprehensive search string for use in both PubMed and Web of Science, two major biomedical searchable databases available to EPA scientists. Google scholar was also searched for additional unique research articles. Inclusion criteria were a direct epidemiologic measure of glyphosate (as opposed to all herbicides, or all phosphonic acid pesticides), and English language publication. Publication date was not restricted, but most articles were published 1990 to present. HED excluded articles that did not make an epidemiological risk estimate of glyphosate exposure in relation to an adverse health outcome (exposure only, acute toxicity only, experimental toxicology study, ecologic risk study, or other review or commentary), or were not full text articles (e.g., abstract only). There were 90 articles initially identified using the search string; of these, 59 were excluded and 31 included in full text review. Among the 31, only 10 were included in the review. Citation mapping added an additional 40 articles, of which 36 were derived from examination of two recent review articles (Mink, Mandel, Lundin, & Sceurman, 2011; P. J. Mink, J. S. Mandel, B. K. Sceurman, & J. I. Lundin, 2012), and four were identified using citation mapping techniques. An additional 5 articles were identified through the European Food Safety Authority pesticide epidemiology systematic review[6]. Therefore, there are 55 epidemiology studies included in the review of glyphosate evaluating both cancer and non-cancer chronic disease endpoints. A full description of literature review methodology is in Appendix 4 which includes a comprehensive listing of all articles identified and excluded based upon title and abstract review or full text evaluation, and a listing of the final 55 articles included in the review.

b. Summary of Glyphosate Epidemiology Literature

As discussed above, glyphosate is a non-selective herbicide registered for use on a variety of fruit, vegetable, and field crops, as well as for residential uses. Glyphosate can be applied pre- or post-emergence, or during the growing season. Therefore, given the number of use sites and the range of timing of application, the exposure potential is substantial. Available experimental evidence indicates that the acute and chronic toxicity of the pesticide is low by all routes of exposure, and well characterized as a result of submitted guideline studies. Glyphosate has been classified as a "Group E" chemical (evidence of non-carcinogenicity for humans), based upon lack of convincing evidence of carcinogenicity in adequate studies in two animal species (mice and rats). This section presents information pertaining to potential glyphosate toxicity in the human population. Epidemiology study review is important for several reasons: animal data are

[5] http://www.epa.gov/pesticides/science/literature-studies.html
[6] http://www.efsa.europa.eu/en/supporting/pub/497e.htm

not always good surrogates for health effects of chemicals in the human population; the exposure range in animal studies are typically much higher than experienced in "real world" human populations; and, human studies better reflect toxicity of the end-use product, as opposed to the active ingredient as well as exposure to a mixture of compounds. Considering this information, the results of observational studies in the human population are considered herein.

Studies included in this review evaluate both cancer and non-cancer health outcomes. Many of the studies included are from the Agricultural Health Study (AHS); however, there are several analyses from population-based case control studies in other parts of the Midwest, Canada and Europe. In addition, use of glyphosate in the control of illegal crops, *e.g.*, cocaine, is common in some parts of the world; there is one study included which was performed in South America (Columbia), in which this use is prevalent. It should be noted that, with only one exception, all the studies included in this review evaluate glyphosate *in addition to* several (dozen in some instances) other agricultural pesticides in relation to a potential health outcomes; glyphosate was only *a priori* identified as a compound of interest in the cohort study on glyphosate in the AHS in which glyphosate exposure and all cancer risks were compared. While there are several dozen studies included in this review, there may be only a few studies for each chronic health endpoint upon which to assess consistency of findings. Therefore, while the pesticide epidemiology database for glyphosate exposure is large in comparison to other active ingredients, it is still unfortunately limited in making causal inference for specific chronic disease outcomes. A summary of the observational studies of the human health effects of glyphosate is presented in this section.

b.1. Non-Cancer Effects

Epidemiological studies of the potential role of glyphosate, among other compounds, in the etiology of several non-cancer health effects are detailed in this sub-section.

b.1.1. Adverse Birth Outcomes

Several studies evaluated the role of pesticides and increased risk of adverse developmental and reproductive health outcomes. Pesticide exposure in relation to pregnancy complications such as gestational diabetes and increased time to pregnancy (TTP) as well as reproductive conditions like small-for-gestational age (SGA) and low birthweight are included in this section. Study authors also reviewed the potential role of pesticides in adverse birth outcomes such as neural tube defects (NTD), congenital malformations, and spontaneous abortion. A brief summary of these reports is included in this section.

Two studies evaluated time to pregnancy in relation to exposure to pesticides, hypothesizing that pesticide exposure may interfere with fecundability among those exposed. Within the Ontario Farm Family study, Curtis et al. (1999) reported some evidence of increased TTP (40% increase in TTP) among women exposed to glyphosate pre-conception (fecundability rate ratio (FRR)

0.61 (95% CI 0.24, 1.05)). Authors did not observe evidence of increased time to pregnancy given fathers exposure to glyphosate prior to conception (Curtis, Savitz, Weinberg, & Arbuckle, 1999). Authors state they identified no clear pattern of pesticide use in relation to TTP, but use of herbicides in general was more strongly linked to this outcome. The exclusion of sub-fertile and infertile women as well as potential exposure misclassification could have attenuated the effects estimates. However, unmeasured positive confounding and chance could explain positive findings. Authors did not identify any one pesticide as strongly linked to TTP in this study, indicating further research is needed. In a separate investigation using ecologic exposure assessment methods, authors examined use of Roundup (glyphosate end use product) by illicit drug production area. Sanin et al (2009) and colleagues reported some evidence of reduced time to pregnancy among women who reside in areas of Columbia (South America) in which illicit drug eradication programs using glyphosate are of the greatest intensity (FRR 0.15 (0.12, 0.18)) (Sanin, Carrasquilla, Solomon, Cole, & Marshall, 2009). Both studies investigating TTP in relation to pesticide use have uncertainties, making it difficult to draw firm conclusions. The indirect (and ecologic) nature of the pesticide exposure assessment in both evaluations dictate further follow-up before a link with this reproductive health endpoint can be established.

HED also identified studies on pregnancy outcomes such as pre-term delivery and small-for-gestational age in relation to pesticide use. Across these studies, there is little evidence of a role for glyphosate. Savitz et al. (1997) reported a non-statistically significant association between glyphosate use and preterm delivery (OR (95% CI) 1.5 (0.8, 2.7), and no link with SGA (OR (95% CI) 0.80 (0.20, 2.3)) (Savitz, Arbuckle, Kaczor, & Curtis, 1997). However, the authors acknowledge the study requires replication as there is insufficient evidence to suggest a role for any specific pesticide in this study. Garry et al. (2002) evaluated pesticide use and male:female sex ratio in an agricultural area of the U.S., but did not report any glyphosate-specific risk estimate because there was no significant exposure-response relation with this chemical (Garry et al., 2002).

While other pesticide epidemiology studies have reported an association with low birth weight and pesticide exposure (Whyatt et al., 2004), Sathayanarayana et al. (2010) did not observe such a link when considering glyphosate use in the AHS cohort (Sathyanarayana et al., 2010). In the cross-sectional study, authors compared lifetime glyphosate use (as reported by female spouses of male pesticide applicators) and range of pregnancy time period. Other pesticides were marginally linked to low birth weight, but glyphosate was not associated with this outcome. Further Saldena et al. (1999) performed a cross-sectional analysis of pesticide use and gestational diabetes in the AHS cohort. Among 11,273 pregnancies reported among women enrolled in the cohort study, authors did not observe a relation between gestational diabetes and self-reported, ever-use of glyphosate during the first trimester of the most recent pregnancy. While errors in the timing of exposure (misclassification) and residual confounding could have reduced the observed effect estimates, the observation of a link with some pesticides, but not glyphosate, suggest the herbicide may not play a role in GD, based upon the evidence in this study.

There were several studies of birth malformations in relation to pesticide use including glyphosate. Rull et al examined the relation between glyphosate and other pesticides and birth certificate reported incidence of neural tube defects (Rull, Ritz, & Shaw, 2006). Cases (731) were births between 1987-1991 in CA, and pesticide exposure was measured as maternal residential proximity to an agricultural field treated with specific pesticides. Authors reported non-statistically significantly elevated (50%) risk of NTD among glyphosate exposed women, adjusting for education, ethnicity, peri-conception smoking and vitamin use. Results were attenuated upon mutual adjustment for exposure to other pesticides (OR (95% CI) 1.4 (0.8, 2.5)). Authors pooled two population-based case control studies to increase the number of birth defect cases included in the study. However, major findings from this pooled analysis related to other pesticides (methomyl, benomyl), and not glyphosate. The non-significant result could be explained by exposure misclassification (which would not likely be differential since residential address and not self-report was used in exposure assessment), residual confounding by factors negatively related to both pesticide use and NTD, or small number of glyphosate exposed cases. Garcia et al. (1998) initially identified a positive association between congenital malformations and glyphosate (OR (95% CI) 1.23 (0.59, 2.56), but the association attenuated considerably upon mutual adjustment for other risk factors including spontaneous abortion, drug use, smoking, education, occupational exposure to other pesticides, and age (OR (95% CI) 0.94 (0.37, 2.56) (Garcia, Benavides, Fletcher, & Orts, 1998). Arbuckle et al. (2001) reported non-statistically significantly elevated risk of spontaneous abortion among women who were exposed to glyphosate pre-conception (OR (95% CI) 1.7 (1.0, 2.9)) and post-conception (OR (95% CI) 1.4 (0.80, 2.5))(Arbuckle, Lin, & Mery, 2001). There were many strengths of this study including the ability to measure exposure in the pre- and post-conception time periods; however authors of this study urge caution in the interpretation of results because many different statistical tests were performed, and exposure misclassification is possible. Glyphosate exposure was among the key findings of the study (atrazine and carbaryl also associated with spontaneous abortion in this study). Considering the totality of the scientific data concerning adverse birth outcomes, there is little overall evidence of a role for glyphosate at this time.

b.1.2 Respiratory Effects

Within the AHS, authors have made several evaluations of respiratory health effects and pesticide exposure including asthma, chronic bronchitis, rhinitis and wheeze. Each investigation utilized a cross-sectional study design; however, given the study was with the prospective AHS and the use of certain analytic methods, concerns about temporal bias (exposure did not precede onset of respiratory health effect) are somewhat ameliorated. In addition, each study was hypothesis-generating in nature such that all pesticides within the AHS were measured in association with incidence or prevalence of these health effects. Across these studies, there were some observations of positively elevated risks of adverse respiratory health in association with glyphosate use; however, for the most part, other compounds were more strongly associated with respiratory health. Given the hypothesis-generating nature of these studies, many statistical tests

performed and the potential for unmeasured, positive confounding bias that may explain outcomes, more research is needed to clarify whether glyphosate truly plays a role in respiratory health.

Hoppin et al. (2008, 2009) evaluated adult-onset asthma and prevalence of atopy in both men and women enrolled in the AHS. Atopy is the presence of other allergic conditions such as hay fever and eczema. Authors observed elevated odds of asthma among those with and without atopy in both men and also women among those who report use of glyphosate. Results were similar for men and women and did not statistically differ between those with and without atopy (Women: atopic asthma: OR (95% CI) 1.31 (1.02, 1.67); non-atopic asthma: OR (95% CI) 1.13 (0.92, 1.39), p-value 0.40; Men: atopic asthma: OR (95% CI) 1.37 (0.86, 2.17), non-atopic asthma: OR (95% CI) 1.15 (0.87, 1.51)) (Hoppin et al., 2008; Hoppin et al., 2009). Glyphosate was one of two herbicides among 11 different herbicides tested that were statistically significantly association with asthma in this study and chance may therefore play a role; other pesticides were more strongly related to asthma in this study. Rhinitis, or runny nose, was marginally, but significantly, associated with glyphosate use among both private but not commercial applicators (odds at least one rhinitis episode in past year: 1.09 (1.05, 1.13); odds 13+ episodes rhinitis in past year: 1.14 (1.07, 1.21), global p=0.001)) (Slager et al., 2009; Slager et al., 2010). The authors did not observe a relation with chronic bronchitis among either men (OR 0.99 (95% CI (0.82, 1.19)) or farm women (1.07 (95% CI (0.89, 1.29)) (Hoppin et al., 2007; Valcin et al., 2007). There is little evidence of a role for glyphosate in the prevalence of wheeze among either private or commercial pesticide applicators, and risk estimates attenuate considerably upon mutual adjustment for pesticides and chlorimuron-ethyl specifically (Hoppin, Umbach, London, Alavanja, & Sandler, 2002; Hoppin et al., 2006). While these authors note an elevated odds of wheeze among glyphosate users who are not also asthmatics (OR (95% CI) 1.5 (1.1, 2.1)), researchers also note that a healthy worker effect in which applicators with asthma or wheeze avoid chemical exposure, making the effect estimate for non-asthmatics artificially higher than asthmatics (Hoppin et al., 2002). These studies indicate a possible role for pesticides in respiratory health; however glyphosate is not strongly suggested as a risk factor based upon these data.

Overall, while some significantly elevated odds of adverse respiratory health outcomes were observed in relation to glyphosate use, the number of statistical tests, the hypothesis-generating nature of these studies, and the limited ability to co-adjust for other pesticides (particularly in studies of women) render the database insufficient to make a determination of the role of glyphosate in these outcomes.

b.1.3 Other Non-Cancer Effects

HED also identified epidemiology studies of other non-cancer health effects in relation to pesticide use including glyphosate exposure. Endpoints include auto-immune (rheumatoid arthritis) and endocrine (diabetes) effects, dysfunction of the cardiac (myocardial infarction) and

neurological (Parkinson's disease) systems, respiratory health, and retinal degeneration. DeRoos et al. (2005) examined the association between pesticide use including glyphosate and the incidence of rheumatoid arthritis (RA) in a nested case control study in the AHS. Among 135 RA cases and 675 matched controls, authors did not observe a link with RA by self-reported glyphosate use (odds ratio (OR (95% CI) 1.2 (0.8, 1.8)), and there was no difference in risk by study state (IA or NC) (De Roos, Cooper, Alavanja, & Sandler, 2005). Given the cross-sectional nature of the study, disease initiation could have preceded pesticide use (temporal bias) affecting the risk estimate (under-estimate if prevalent cases mixed with new cases). However, authors conclude on the basis of this study that other farm exposures excluding pesticide use may be more strongly related to RA etiology. In another study within the AHS, Kirrane et al. (2005) examined retinal degeneration (RD) among wives of enrolled pesticide applicators in relation to pesticide use. Among 31,173 women enrolled in the study, authors did not observe an association between self-reported, ever-use of glyphosate and RD (OR (95% CI) 1.1 (0.8, 1.5)) (Kirrane et al., 2005).

Kamel et al. (2007) performed an analysis of both incident and prevalent Parkinson's disease (PD) in relation to pesticide use among AHS participants. Among 79,557 private and commercial pesticide applicators, authors identified 83 prevalent and 78 incident cases of PD. PD status was measured as a result of participants self report of a physician diagnosis of the condition (no confirmation). Pesticide use was also measured using the AHS self-report questionnaire from which lifetime exposure days was calculated. Adjusting for age, state and type of applicator (or spouse of applicator), authors did not observe a significant, positive association between glyphosate and either incident (OR (95% CI) 1.1 (0.6, 2.0), or prevalent PD (OR (95% CI) 1.0 (0.6, 1.7)) (Kamel et al., 2007).

Similarly, a study of cardiac effects in relation to pesticide use in the AHS did not identify any links with glyphosate. Because risk factors for heart attack (MI) differ greatly between men and women, authors examined each group in separate studies. Controlling for the age, state, smoking, BMI, and the use of other pesticides (only among men), authors did not observe any association between incident MI or mortality due to MI among either male or female participants in the AHS with glyphosate – relative risks were the null value (1.0) (Dayton et al., 2010; Mills, Blair, Freeman, Sandler, & Hoppin, 2009).

AHS authors also examined diabetes in relation to pesticide use, and did not observe evidence of an association with glyphosate (OR (95% CI) 0.85 (0.74, 0.98) (Montgomery, Kamel, Saldana, Alavanja, & Sandler, 2008). Similarly, AHS study authors found no association between thyroid disease and glyphosate use in a cross-sectional analysis in the AHS; hyper-thyroidism: 0.98 (0.78., 1.2); hypo-throidism: 1.0 (0.91, 1.2); and, "other" thyroid disease: 0.97 (0.81, 1.2) (Goldner et al., 2010).

While these non-cancer health endpoints are wide ranging, in most instances only one study was available for a specific endpoint, therefore making it challenging to assess consistency in the

human population. Across these varied non-cancer, chronic health endpoints, there is little evidence of a role for glyphosate in the etiology of these non-cancer health effects.

b. 2. Cancer Effects

An effect estimate of the relation between glyphosate and other pesticide exposure and several different anatomical cancer sites is included in this literature review. Mainly performed within the AHS cohort, this literature review includes studies of prostate, lung, and colorectal cancer in addition to less common cancers in the human population such as pancreatic and stomach cancer in association with pesticide use. The role of pesticide use and lymphohematopoietic cancers and particularly non Hodgkin lymphoma (NHL) has been studied in several investigations external to the AHS cohort. For most of the cancer endpoints studied in relation to pesticide use, only one epidemiology study is available; however, for NHL and other non-solid tumors, several investigations are published. In this section, we present a summary of the studies evaluating the carcinogenic potential of glyphosate and other pesticides in the human population.

b.2.1 Solid Tumor Cancer Studies (non-lymphohematopoietic (LHP) cancers)

Within the AHS study cohort, authors evaluated several anatomical cancer sites in relation to pesticide use. None of these investigations reported a significant statistical association with lifetime use of glyphosate specifically. While these are all initial, hypothesis-generating studies and require further follow-up studies to determine whether the true association with glyphosate is indeed null, the large sample size, extensive exposure data collection and validation, and comprehensive confounding variable adjustment in the AHS supports a conclusion of no association between glyphosate use and cancers studied at this time. In a cohort analysis of all glyphosate users, authors did not observe an association with all cancers combined (OR 1.0 (95% CI (0.90, 1.2)) or specific anatomical cancer sites, with the exception of a non-statistically significantly elevated risk of multiple myeloma based upon a small number of glyphosate exposed cases (De Roos, Blair, et al., 2005). A discussion of studies external to the AHS cohort that addressed pesticide use in relation to non-solid tumors including multiple myeloma and NHL is presented below in section b.2.2 below.

Several AHS nested case-control analyses also provide information concerning the carcinogenic potential of glyphosate; there is no statistical evidence of an association with glyphosate presented across these investigations. Specifically, AHS researchers reported no statistical evidence of an association between glyphosate use and breast cancer (OR 0.9 (95% CI (0.1, 1.1)) (Engel et al., 2005), colorectal cancer (OR 1.6 (95% CI (0.9, 2.9)) (W. J. Lee et al., 2007), lung cancer (no results shown due to lack of statistically significant risk estimate) (Alavanja et al., 2004), pancreatic cancer (OR (95% CI) 1.1 (0.6, 1.7)) (Andreotti et al., 2009), and prostate cancer (no results shown due to lack of statistically significant risk estimate) (Alavanja et al., 2003; Koutros et al., 2013), as well as cutaneous melanoma (no results shown due to lack of statistically significant risk estimate) (Dennis, Lynch, Sandler, & Alavanja, 2010). In a

population-based study external to the AHS, Canadian researchers reported non-significantly elevated odds of prostate cancer in relation to glyphosate use (OR 1.36 (95% CI 0.83, 2.25)) (Band et al., 2011). This study enrolled prostate cancer cases between1983-1990, prior to the PSA-era; therefore, the study includes more advanced tumors upon diagnosis, and is not comparable to Alavanja et al. (2003), which reflects cases during the PSA-era in which cases are typically identified at an earlier stage in the natural history of disease. Notably, in a prostate cancer follow-up study within the AHS, Koutros et al. (2013) did not identify an association with advanced prostate cancer (OR (95% CI) 0.93 (0.73, 1.18)) (Koutros et al., 2013). AHS investigators also examined the relation between parental pesticide use and all pediatric cancers reported to state registries among children of AHS participants and did not observe a significant association with glyphosate use (maternal exposure to glyphosate: OR (95% CI) 0.61 (0.32, 1.16)); paternal exposure to glyphosate: OR (95% CI) 0.84 (0.35, 2.54)) (Flower et al., 2004).

Brain Tumors (Glioma): Population-Based Case Control Studies: External to the AHS cohort study, HED identified population-based case control studies which evaluated brain cancer in relation to pesticides use. Glioma is the most common type of brain tumor. In a study of ever-use of pesticides, authors identified 251 glioma cases between 1988 and 1993 in Nebraska, and controls (n=498) identified from the same region. Matching for age and vital-status, study authors reported a non-significant elevated odds of glioma (OR 1.5 (95% CI (0.7, 3.1)) in relation to glyphosate use; however the results were significantly different between those who self-reported pesticide use (OR 0.4 (95% CI (0.1, 1.6)), and for those whom a proxy respondent was used (3.1 (95% CI (1.2, 8.2)), indicating recall bias was likely a characteristic of this study (W. Lee et al., 2005). Three other population-based case control studies of glioma risk were part of this literature review; authors investigated the question among men and also among women participating in the Upper Midwest Health Study ((Carreon et al., 2005; Ruder et al., 2004; Yiin et al., 2012). Among glioma cases identified 1995-1997, authors found little evidence of a role of glyphosate in the etiology of this tumor. While herbicide use overall was non-statistically significantly linked to glioma in the study among men (OR 1.51 (95% CI (0.92, 2.48)), use of glyphosate was not linked to glioma among women (OR 0.7 (95% CI (0.4, 1.3). In the study by Carreon et al. (2005), there was no difference in risk estimate by vital status (use of self-report or proxy respondent), suggesting recall bias was more limited in this study in contrast to the study by Lee et al. (2005) noted above. Using a quantitative measure of pesticide exposure (in contrast to an ever-use metric), authors similarly observed no statistical evidence of an association with glyphosate; risk estimates were roughly equal to the null value (occupational use: OR 0.98 (95% CI 0.67, 1.43); home and garden use: OR 0.83 (95% CI 0.39, 1.73))(Yiin et al., 2012). Overall, this database presents little statistical evidence that there is a role for glyphosate in glioma risk in the Midwestern U.S.

Adenocarcinoma: Population-Based Case Control Study: In another population based case control study in the Midwest (NE), authors evaluated pesticide use and adenocarcinoma. Researchers did not observe an association between glyphosate exposure and either stomach

cancer (OR (95% CI) 0.8 (0.4, 1.5)) or esophageal cancer (OR (95% CI) 0.7 (0.3, 1.4)) (W. Lee et al., 2004). Exposure assessment was based upon self report pesticide use, with follow-up telephone interview to verify reported information. Cancer cases were identified through the state cancer registry, and confirmed by pathologist. While non-differential misclassification of either pesticide use could have occurred and attenuated or obscured results, it is unlikely there is a strong positive association with glyphosate and adenocarcinoma based the evidence presented in this study.

b.2.2 Non-Solid Tumor Sites (Lymphohematopoietic cancers)

There are several epidemiology studies of the possible link between pesticide use and lymphohematopoietic cancers; the study of NHL is particularly well represented in this small epidemiology database. All studies are case-control in design; there are no prospective cohort evaluations of this potential association. The presence of case control study design across this database limits development of firm causal inference.

Leukemia: In a population-based case control study in Iowa and Minnesota, authors investigated leukemia risk and pesticide use; authors did not observe an association with the ever-use of glyphosate in this study (OR (95% CI) 0.9 (0.5, 1.6)) (Brown et al., 1990). The study population was identified from cancers reported to state registry or authorities in 1981-1984, and pesticide exposure assessment was performed through in-person interview which authors state likely reduced exposure misclassification (incorrect exposure information). The large sample size (578 cases and 1245 controls), exposure assessment methods, and confounding variable control are strengths of the study; however the lack of clear exposure-response information and the potential for recall bias are also present. In another population based case control study, cases were identified in 1987-1992 through the Swedish cancer registry. Authors reported a non statistically significant elevated risk of hairy cell leukemia in relation to glyphosate use (OR (95% CI) 3.1 (0.8, 12.0), controlling for age, gender, and residential location (Nordstrom, Hardell, Magnuson, Hagberg, & Rask-Andersen, 1998). However, these results are based on only 4 and 5 glyphosate exposed cases and controls, respectively, and should be interpreted with caution, as noted by the authors. At this time, the limited available literature concerning glyphosate use and leukemia cannot support a conclusion that glyphosate plays a role in leukemia.

Multiple Myeloma (MM): Using the same study population as noted above in reference to leukemia risk and pesticide use, Brown et al. (1993) studied whether pesticide use is also related to MM. Among men in Iowa (173 cases, 605 controls), authors observed a statistically non-significant elevated association with glyphosate use (OR (95% CI) 1.7 (0.80, 3.6))(Brown, Burmeister, Everett, & Blair, 1993). However, authors caution that while the study may lend support for the role of pesticides in general, the study limitations preclude use of evidence in support of any one compound. In the AHS cohort analysis by de Roos et al. (2005), researchers also reported a non-statistically significantly elevated risk of multiple myeloma among glyphosate users (OR 2.6 (95% CI (0.70, 9.4)), but this results was based upon only 32 MM

cases (20 of whom reported exposure to glyphosate), and authors did not observe evidence of an exposure-response trend by duration or intensity of pesticide use (De Roos, Blair, et al., 2005). Authors suggest there are too few cases of glyphosate exposed MM in the study to make a firm conclusion. In a population-based case control study in Canada, researchers reported non-statistically significantly elevated odds of MM in relation to glyphosate use (OR (95% CI) 1.22 (0.77, 1.93), based upon 32 and 133 glyphosate exposed MM case and controls, respectively (Pahwa et al., 2012). Within the AHS study population, molecular epidemiology researchers studied the association between pesticide use and prevalence of monoclonal gammopathy of undetermined significance (or MGUS); MGUS is considered a pre-clinical marker of MM progression. Authors did not observe a link with glyphosate use in the AHS cohort (OR 0.50 (95% CI (0.20, 1.0)) (Landgren et al., 2009). At this time, the epidemiologic database regarding the possible link between pesticide use and MM is too small and inconsistent to determine whether glyphosate plays a role in this cancer.

Lymphoma: The National Cancer Institute (NCI) performed a series of population-based case control studies in the Midwestern U.S. in the early to mid-1980s. These studies include several hundred NHL cases and controls, identified cases through disease registries which in many cases were histopathologically confirmed. Investigators ascertained pesticide exposure through use of a structured interview with follow-up concerning pesticide use over time. Early investigations (IA and MN) did not observe a link with ever-use of glyphosate (OR (95% CI) 1.0 (0.5, 2.2)); however authors did not adjust for exposure to other pesticides in this study (Cantor et al., 1992). Pooling data from several Midwestern states to increase study sample size (IA, MN, NE), and using additional pesticide use information to adjust the risk estimate (duration and frequency of use, telephone follow-up interview), Lee et al. (2004) observed a positive, non-significant association with glyphosate among those without asthma (OR (95% CI) 1.4 (0.98, 2.1)), adjusting for age, state and vital status (W. J. Lee, Cantor, Berzofsky, Zahm, & Blair, 2004). In a pooled analysis (n=3,417) of these same three study states, and utilizing hierarchical regression techniques to adjust for exposure to other pesticide exposures, authors observed a similarly elevated, but non-statistically significant result: OR (95% CI) 1.6 (0.90, 2.8) (De Roos et al., 2003). These three evaluations reflect the same study population, use different levels of information (duration and frequency of exposure) and different analytic techniques (hierarchical regression and stratified analysis (by atopy)). While studies with increasing levels of refinement to method report a stronger risk estimates in relation to glyphosate, additional studies are needed to exclude the role of chance and other limitations that may explain positive (non-statistically significant) associations.

Hardell et al. (1999 and 2002) performed two analyses of the possible link between pesticide use and NHL using the Swedish cancer registry and a telephone based exposure questionnaire to determine pesticide use. The initial investigation of 404 NHL cases and 741 control subjects included only 4 and 5 glyphosate exposed cases and controls, respectively. The risk estimate was elevated, but precision was low (OR (95% CI) 2.3 (0.40, 13.0)) (L Hardell & Eriksson, 1999). In

a pooled analysis reflecting the same study time period and prevalence of glyphosate use, Hardell et al. (2002) reported a non-statistically elevated odds of NHL among glyphosate users: OR (95% CI) 1.85 (0.55, 6.20)), however this estimate also lacks precision (L. Hardell, Eriksson, & Nordstrom, 2002). Authors stated glyphosate use was low in the time period of the study 1987-1990. Therefore, authors performed a new study in later time period (1999-2003) in which glyphosate use had increased. In this study, authors observed a similar risk estimate (OR (95% CI) 1.55 (0.77, 2.94)), among 910 NHL cases and 1016 non-NHL controls (Eriksson, Hardell, Carlberg, & Akerman, 2008). Authors conclude that the follow-up study, with a greater number of glyphosate exposed participants lends support to the conclusion glyphosate may play a role in NHL.

Within the Cross- Canada study of pesticides and health, authors estimated the association between glyphosate and NHL as well. These investigations reflect cases identified 1991-1994 through provincial cancer registries. In this study, authors histopathologically confirmed 84% of cases, and implemented a two-tiered exposure questionnaire, and assessed the validity of the questionnaire through quality control studies both of which increased the accuracy of the study results. Glyphosate was not among the primary findings of either study. The initial study within this population identified a non-statistically significant 20% increased risk of NHL (OR (95% CI) 1.20 (0.83, 1.74))(McDuffie et al., 2001), which attenuated in a follow-up study which controlled for exposure to other pesticides (OR (95% CI) 0.92 (0.54, 1.55)) (Hohenadel et al., 2011). Within this series of studies, authors also evaluated Hodgkin lymphoma (HL), and similarly observed little statistical evidence of an association, using similar study design and methods (OR (95% CI) 0.99 (0.62, 1.18)) (Karunanayake et al., 2012). In a separate study using a hospital-based case control study design (France (2000-04)), authors identified 491 NHL cases and 456 non-cases, and performed telephone-based questionnaire to assess pesticide and other confounding variables. Investigators did not observe an association between NHL and glyphosate use (OR (95% CI) 1.0 (0.50, 2.2)) (Orsi et al., 2009).

c. Glyphosate Summary

HED identified 55 environmental epidemiology studies regarding potential cancer and non-cancer, chronic health effects in association with pesticide use including glyphosate. As noted above, few of these studies reflected an *a priori* research interest in the potential role of glyphosate and chronic disease outcomes. Most studies were hypothesis-generating in nature, and study authors evaluated use of glyphosate in addition to several other pesticides. Therefore, the role of chance given the many different statistical tests performed and the lack of a pre-specified hypothesis limit epidemiologic inference. Given this and other limitations of these studies, we cannot conclude glyphosate plays a role in any of the health outcomes studied across this epidemiologic database. EPA will continue to follow the literature concerning the potential role of the chemical in respiratory health (asthma in particular), as well as adverse pregnancy and birth outcomes such as increased time to pregnancy. Across the several population-based case-control studies on NHL and pesticide use, some investigators observed non-statistically

significantly increased risk in relation to glyphosate use, while others reported no observation of a statistical association with glyphosate use. Variation in the quality of exposure assessment, study design and methods, as well as available information concerning potential confounding variables could explain these inconsistencies in the data. A prospective study devoid of the limitations of exposure recall inherent to case control studies will greatly aid causal inference. EPA will await with interest any new study using prospective exposure assessment methods to investigate the role of glyphosate and NHL and other lymphohematopoietic tumors.

5. CONCLUSIONS

The relatively high number of reported glyphosate incidents across the reviewed databases is likely a result of glyphosate being among the most widely used pesticides by volume. It should be noted that, most of the incidents reported are minor in severity meaning the symptoms were minimally traumatic and resolved rapidly.

HED found that the acute health effects reported to the incident databases queried are consistent with the previous incident report, and the other databases and medical literature reviewed. These health effects primarily include dermal, ocular, and respiratory effects. HED did not identify any aberrant effects outside of those anticipated. While inconvenient for those who suffer adverse health effects, effects are generally mild/minor to moderate and resolve rapidly.

The incident data available from IDS and NPIC suggest that homeowner mixing/loading/ applying (usually due to human errors and container leaks) are responsible for almost half of the reported incidents. SENSOR-Pesticides incident data are consistent with IDS and NPIC, also suggesting that application of glyphosate results in the most reported incidents (50%). However, the SENSOR-Pesticide incidents include both residential and occupational incidents. The incident data available from CA PISP suggests that occupational handling of equipment is responsible for most incidents due to equipment leaks and malfunction.

All of the databases showed occurrence of children's' exposures (ranging from 5% to 27% of the total). Based on the data in SENSOR, IDS, and NPIC, it appears that the childrens' exposures are due to postapplication exposure, accidental ingestion, and tampering with the product. Ocular exposure and symptoms were reported in all of the databases, to both occupational and nonoccupational users, as a result of splash to the face or touching their eyes with the product on their hands. These symptoms primarily included eye irritation, redness, burning and blurred vision.

Trends over time data from IDS (2008 to 2012), PISP (2005 to 2010), SENSOR-Pesticides (1998 to 2009) and AAPCC (2001 to 2012) data were reviewed. Based on IDS and AAPCC, which are primarily non-occupational cases, incidents appear to be decreasing over time. CA PISP data represents both occupational and non-occupational incidents. This data appears to be relatively

steady over time. The SENSOR-Pesticide data also represent both occupational and non-occupational cases. For this data, occupational case reports involving glyphosate appeared to be increasing until 2008 and non-occupational case reports appear to be increasing over time. The increase in non-occupational case reports may be reflective of increased SENSOR state capacity to collect non-occupational pesticide surveillance data.

Although animal studies showed glyphosate to have limited toxicity, medical case reports suggest that glyphosate end use products (formulated with different glyphosate salts and various concentrations of surfactants and adjuvants), may be more toxic than the active ingredient alone. Since human poisoning reviewed were not with the active ingredient (glyphosate) alone but with various mixtures, it is not easy to identify the exact cause. Nevertheless, the medical literature reviewed indicates that most of the accidental ingestions of glyphosate formulations resulted in mild symptoms such as irritation of oral and upper gastrointestinal mucosa and were self limited. However, intentional ingestions caused moderate to severe symptoms in multiple organs.

While HED identified several dozen glyphosate environmental epidemiology studies, few of these studies reflected an *a priori* research interest in the potential role of glyphosate and chronic disease outcomes, and most studies were hypothesis-generating in nature. Given this and other limitations of these studies, we cannot conclude glyphosate plays a role in any of the health outcomes studied across this epidemiologic database. EPA will continue to follow the literature concerning the potential role of the chemical in certain cancer and non-cancer outcomes. There were several (case control) studies evaluating the role of pesticide exposure including glyphosate and lymphohematopoietic cancers like NHL however limitations of study design and exposure assessment methods restrict the ability of these studies to inform causal inference. A prospective study devoid of the limitations of exposure recall inherent to case control studies could greatly clarify the current database. EPA will await with interest any new study using prospective exposure assessment methods to investigate the role of glyphosate and NHL and other lymphohematopoietic tumors.

References

Aaron, C. (2006). *Rosen's Emergency Medicine: Concepts and Clinical Practice.* (6th ed.).

Alavanja, M. C., Dosemeci, M., Samanic, C., Lubin, J., Lynch, C. F., Knott, C., . . . Blair, A. (2004). Pesticides and lung cancer risk in the agricultural health study cohort. *Am J Epidemiol, 160*(9), 876-885. doi: 160/9/876 [pii]
10.1093/aje/kwh290

Alavanja, M. C., Samanic, C., Dosemeci, M., Lubin, J., Tarone, R., Lynch, C. F., . . . Blair, A. (2003). Use of agricultural pesticides and prostate cancer risk in the Agricultural Health Study cohort. A*m J Epidemiol, 157(*9), 800-814.

Amerio, P., Motta, A., Toto, P., Pour, S. M., Pajand, R., Feliciani, C., & Tulli, A. (2004). Skin toxicity from glyphosate-surfactant formulation. J *Toxicol Clin Toxicol, 42(*3), 317-319.

Andreotti, G., Freeman, L. E., Hou, L., Coble, J., Rusiecki, J., Hoppin, J. A., . . . Alavanja, M. C. (2009). Agricultural pesticide use and pancreatic cancer risk in the Agricultural Health Study Cohort. I*nt J Cancer, 124(*10), 2495-2500. doi: 10.1002/ijc.24185

Arbuckle, T. E., Lin, Z. Q., & Mery, L. S. (2001). An exploratory analysis of the effect of pesticide exposure on the risk of spontaneous abortion in an Ontario farm population. E*nvironmental Health Perspectives, 109(*8), 851-857.

Band, P. R., Abanto, Z., Bert, J., Lang, B., Fang, R., Gallagher, R. P., & Le, N. D. (2011). Prostate cancer risk and exposure to pesticides in British Columbia farmers. P*rostate, 71(*2), 168-183. doi: 10.1002/pros.21232

Bando, H., Murao, Y., Aoyagi, U., Hirakawa, A., Iwase, M., & Nakatani, T. (2010). [Extreme hyperkalemia in a patient with a new glyphosate potassium herbicide poisoning: report of a case]. C*hudoku Kenkyu, 23(*3), 246-249.

Bradberry, S. M., Proudfoot, A. T., & Vale, J. A. (2004). Glyphosate poisoning. T*oxicol Rev, 23(*3), 159-167.

Brown, L. M., Blair, A., Gibson, R., Everett, G. D., Cantor, K. P., Schuman, L. M., . . . Dick, F. (1990). Pesticide exposures and other agricultural risk factors for leukemia among men in Iowa and Minnesota. C*ancer Res, 50(*20), 6585-6591.

Brown, L. M., Burmeister, L. F., Everett, G. D., & Blair, A. (1993). Pesticide exposures and multiple myeloma in Iowa men. C*ancer Causes Control, 4(*2), 153-156.

Cantor, K. P., Blair, A., Everett, G., Gibson, R., Burmeister, L. F., Brown, L. M., . . . Dick, F. R. (1992). Pesticides and other agricultural risk factors for non-Hodgkin's lymphoma among men in Iowa and Minnesota. C*ancer Res, 52(*9), 2447-2455.

Carreon, T., Butler, M. A., Ruder, A. M., Waters, M. A., Davis-King, K. E., Calvert, G. M., . . . Brain Canc Collaborative Study, G. (2005). Gliomas and farm pesticide exposure in women: The Upper Midwest Health Study. E*nvironmental Health Perspectives, 113(*5), 546-551. doi: 10.1289/ehp.7456

Chang, C. B., & Chang, C. C. (2009). Refractory cardiopulmonary failure after glyphosate surfactant intoxication: a case report. J *Occup Med Toxicol, 4,* 2. doi: 10.1186/1745-6673-4-2

Chang, C. Y., Peng, Y. C., Hung, D. Z., Hu, W. H., Yang, D. Y., & Lin, T. J. (1999). Clinical impact of upper gastrointestinal tract injuries in glyphosate-surfactant oral intoxication. H*um Exp Toxicol, 18(*8), 475-478.

Chen, H. H., Lin, J. L., Huang, W. H., Weng, C. H., Lee, S. Y., Hsu, C. W., . . . Yen, T. H. (2013). Spectrum of corrosive esophageal injury after intentional paraquat or glyphosate-surfactant herbicide ingestion. I*nt J Gen Med, 6,* 677-683. doi: 10.2147/ijgm.s48273

Chen, Y. J., Wu, M. L., Deng, J. F., & Yang, C. C. (2009). The epidemiology of glyphosate-surfactant herbicide poisoning in Taiwan, 1986-2007: a poison center study. C*lin Toxicol (Phila), 47(*7), 670-677. doi: 10.1080/15563650903140399

Curtis, K., Savitz, D., Weinberg, C., & Arbuckle, T. (1999). The effect of pesticide exposure on time to pregnancy. E*pidemiology, 10(*2), 112-117. doi: 10.1097/00001648-199903000-00005

Dayton, S. B., Sandler, D. P., Blair, A., Alavanja, M., Beane Freeman, L. E., & Hoppin, J. A. (2010). Pesticide use and myocardial infarction incidence among farm women in the agricultural health study. J *Occup Environ Med, 52(*7), 693-697. doi: 10.1097/JOM.0b013e3181e66d25

De Roos, A. J., Blair, A., Rusiecki, J. A., Hoppin, J. A., Svec, M., Dosemeci, M., . . . Alavanja, M. C. (2005). Cancer incidence among glyphosate-exposed pesticide applicators in the Agricultural Health Study. E*nviron Health Perspect, 113(*1), 49-54.

De Roos, A. J., Cooper, G. S., Alavanja, M. C., & Sandler, D. P. (2005). Rheumatoid arthritis among women in the Agricultural Health Study: risk associated with farming activities and exposures. A*nn Epidemiol, 15(*10), 762-770. doi: 10.1016/j.annepidem.2005.08.001

De Roos, A. J., Zahm, S. H., Cantor, K. P., Weisenburger, D. D., Holmes, F. F., Burmeister, L. F., & Blair, A. (2003). Integrative assessment of multiple pesticides as risk factors for non-Hodgkin's lymphoma among men. O*ccupational and Environmental Medicine, 60(*9). doi: e11

Dennis, L. K., Lynch, C. F., Sandler, D. P., & Alavanja, M. C. (2010). Pesticide use and cutaneous melanoma in pesticide applicators in the agricultural heath study. E*nviron Health Perspect, 118(*6), 812-817. doi: 10.1289/ehp.0901518

Diamond, G., & Durkin, P. (2011). G*lyphosate Human Health and Ecological Risk Assessment Final Report (USDA).*

Engel, L. S., Hill, D. A., Hoppin, J. A., Lubin, J. H., Lynch, C. F., Pierce, J., . . . Alavanja, M. C. (2005). Pesticide use and breast cancer risk among farmers' wives in the agricultural health study. A*m J Epidemiol, 161(*2), 121-135. doi: 161/2/121 [pii]
10.1093/aje/kwi022

Eriksson, M., Hardell, L., Carlberg, M., & Akerman, M. (2008). Pesticide exposure as risk factor for non-Hodgkin lymphoma including histopathological subgroup analysis. I*nternational Journal of Cancer, 123(7*), 1657-1663. doi: 10.1002/ijc.23589

Fisher, K. R., Higginbotham, R., Frey, J., Granese, J., Pillow, J., & Skinner, R. B. (2008). Pesticide-associated pemphigus vulgaris. C*utis, 82(1*), 51-54.

Flower, K. B., Hoppin, J. A., Lynch, C. F., Blair, A., Knott, C., Shore, D. L., & Sandler, D. P. (2004). Cancer risk and parental pesticide application in children of agricultural health study participants. E*nvironmental Health Perspectives, 112(5*), 631-635.

Garcia, A., Benavides, F., Fletcher, T., & Orts, E. (1998). Paternal exposure to pesticides and congenital malformations. S*candinavian Journal of Work Environment & Health, 24(6*), 473-480.

Garry, V. F., Harkins, M. E., Erickson, L. L., Long-Simpson, L. K., Holland, S. E., & Burroughs, B. L. (2002). Birth defects, season of conception, and sex of children born to pesticide

applicators living in the Red River Valley of Minnesota, USA. En*viron Health Perspect, 110 Suppl 3,* 441-449.

Goldner, W. S., Sandler, D. P., Yu, F., Hoppin, J. A., Kamel, F., & Levan, T. D. (2010). Pesticide use and thyroid disease among women in the Agricultural Health Study. Am *J Epidemiol, 171(4*), 455-464. doi: kwp404 [pii]
10.1093/aje/kwp404

Hardell, L., & Eriksson, M. (1999). A case-control study of non-Hodgkin lymphoma and exposure to pesticides. Can*cer, 85(6)*, 1353-1360. doi: 10.1002/(SICI)1097-0142(19990315)85:6<1353::AID-CNCR19>3.0.CO;2-1

Hardell, L., Eriksson, M., & Nordstrom, M. (2002). Exposure to pesticides as risk factor for non-Hodgkin's lymphoma and hairy cell leukemia: pooled analysis of two Swedish case-control studies. Leu*k Lymphoma, 43(5)*, 1043-1049.

Heras-Mendaza, F., Casado-Farinas, I., Paredes-Gascon, M., & Conde-Salazar, L. (2008). Erythema multiforme-like eruption due to an irritant contact dermatitis from a glyphosate pesticide. Con*tact Dermatitis, 59(1)*, 54-56. doi: 10.1111/j.1600-0536.2007.01307.x

Hohenadel, K., Harris, S. A., McLaughlin, J. R., Spinelli, J. J., Pahwa, P., Dosman, J. A., . . . Blair, A. (2011). Exposure to multiple pesticides and risk of non-Hodgkin lymphoma in men from six Canadian provinces. Int *J Environ Res Public Health, 8(6)*, 2320-2330. doi: 10.3390/ijerph8062320

Hoppin, J. A., Umbach, D. M., London, S. J., Alavanja, M. C. R., & Sandler, D. P. (2002). Chemical predictors of wheeze among farmer pesticide applicators in the agricultural health study. Ame*rican Journal of Respiratory and Critical Care Medicine, 165(5)*, 683-689. doi: 10.1164/rccm.2106074

Hoppin, J. A., Umbach, D. M., London, S. J., Henneberger, P. K., Kullman, G. J., Alavanja, M. C. R., & Sandler, D. P. (2008). Pesticides and atopic and nonatopic asthma among farm women in the agricultural health study. Ame*rican Journal of Respiratory and Critical Care Medicine, 177(1)*, 11-18.

Hoppin, J. A., Umbach, D. M., London, S. J., Henneberger, P. K., Kullman, G. J., Coble, J., . . . Sandler, D. P. (2009). Pesticide use and adult-onset asthma among male farmers in the Agricultural Health Study. Eur*opean Respiratory Journal, 34(6)*, 1296-1303. doi: 10.1183/09031936.00005509

Hoppin, J. A., Umbach, D. M., London, S. J., Lynch, C. F., Alavanja, M. C. R., & Sandler, D. P. (2006). Pesticides associated with wheeze among commercial pesticide applicators in the Agricultural Health Study. Ame*rican Journal of Epidemiology, 163(12*), 1129-1137. doi: 10.1093/aje/kwj138

Hoppin, J. A., Valcin, M., Henneberger, P. K., Kullman, G. J., Umbach, D. M., London, S. J., . . . Sandier, D. P. (2007). Pesticide use and chronic bronchitis among farmers in the agricultural health study. Ame*rican Journal of Industrial Medicine, 50(12*), 969-979. doi: 10.1002/ajim.20523

Hori, Y., Fujisawa, M., Shimada, K., & Hirose, Y. (2003). Determination of the herbicide glyphosate and its metabolite in biological specimens by gas chromatography-mass spectrometry. A case of poisoning by roundup herbicide. J A*nal Toxicol, 27(3)*, 162-166.

Hour, B. T., Belen, C., Zar, T., & Lien, Y. H. (2012). Herbicide roundup intoxication: successful treatment with continuous renal replacement therapy Am *J Med (V*ol. 125, pp. e1-2). United States.

Kamel, F., Tanner, C. M., Umbach, D. M., Hoppin, J. A., Alavanja, M. C. R., Blair, A., . . . Sandler, D. P. (2007). Pesticide exposure and self-reported Parkinson's disease in the agricultural health study. Amer*ican Journal of Epidemiology, 165(4)*, 364-374. doi: 10.1093/aje/kwk024

Kamijo, Y., Mekari, M., Yoshimura, K., Kan'o, T., & Soma, K. (2012). Glyphosate-surfactant herbicide products containing glyphosate potassium salt can cause fatal hyperkalemia if ingested in massive amounts. Cli*n Toxicol (Phila), 50(2)*, 159. doi: 10.3109/15563650.2011.648747

Karunanayake, C. P., Spinelli, J. J., McLaughlin, J. R., Dosman, J. A., Pahwa, P., & McDuffie, H. H. (2012). Hodgkin lymphoma and pesticides exposure in men: a Canadian case-control study. J A*gromedicine, 17(1)*, 30-39. doi: 10.1080/1059924X.2012.632726

Kirrane, E., Hoppin, J., Kamel, F., Umbach, D., Boyes, W., DeRoos, A., . . . Sandler, D. (2005). Retinal degeneration and other eye disorders in wives of farmer pesticide applicators enrolled in the agricultural health study. Amer*ican Journal of Epidemiology, 161(11*), 1020-1029. doi: 10.1093/aje/kwi140

Knezevic, V., Bozic, D., Budosan, I., Celic, D., Milosevic, A., & Mitic, I. (2012). [Early continuous dialysis in acute glyphosate-surfactant poisoning]. Srp *Arh Celok Lek, 140(9-*10), 648-652.

Koutros, S., Beane Freeman, L. E., Lubin, J. H., Heltshe, S. L., Andreotti, G., Barry, K. H., . . . Alavanja, M. C. (2013). Risk of total and aggressive prostate cancer and pesticide use in the Agricultural Health Study. Am *J Epidemiol, 177(1)*, 59-74. doi: 10.1093/aje/kws225

Landgren, O., Kyle, R. A., Hoppin, J. A., Freeman, L. E. B., Cerhan, J. R., Katzmann, J. A., . . . Alavanja, M. C. (2009). Pesticide exposure and risk of monoclonal gammopathy of undetermined significance in the Agricultural Health Study. Blo*od, 113(25*), 6386-6391. doi: 10.1182/blood-2009-02-203471

Lee, C. H., Shih, C. P., Hsu, K. H., Hung, D. Z., & Lin, C. C. (2008). The early prognostic factors of glyphosate-surfactant intoxication. Am *J Emerg Med, 26(3)*, 275-281. doi: 10.1016/j.ajem.2007.05.011

Lee, H. L., Chen, K. W., Chi, C. H., Huang, J. J., & Tsai, L. M. (2000). Clinical presentations and prognostic factors of a glyphosate-surfactant herbicide intoxication: a review of 131 cases. Aca*d Emerg Med, 7(8)*, 906-910.

Lee, W., Colt, J., Heineman, E., McComb, R., Weisenburger, D., Lijinsky, W., & Ward, M. (2005). Agricultural pesticide use and risk of glioma in Nebraska, United States. Occ*upational and Environmental Medicine, 62(11*). doi: 10.1136/oem.2005.020230

Lee, W., Lijinsky, W., Heineman, E., Markin, R., Weisenburger, D., & Ward, M. (2004). Agricultural pesticide use and adenocarcinomas of the stomach and oesophagus. Occ*upational and Environmental Medicine, 61(9)*, 743-749. doi: 10.1136/oem.2003.011858

Lee, W. J., Cantor, K. P., Berzofsky, J. A., Zahm, S. H., & Blair, A. (2004). Non-Hodgkin's lymphoma among asthmatics exposed to pesticides. Int *J Cancer, 111(2)*, 298-302. doi: 10.1002/ijc.20273

Lee, W. J., Sandler, D. P., Blair, A., Samanic, C., Cross, A. J., & Alavanja, M. C. R. (2007). Pesticide use and colorectal cancer risk in the Agricultural Health Study. Int*ernational Journal of Cancer, 121(2)*, 339-346. doi: 10.1002/ijc.22635

Malhotra, R. C., Ghia, D. K., Cordato, D. J., & Beran, R. G. (2010). Glyphosate-surfactant herbicide-induced reversible encephalopathy. J C*lin Neurosci, 17(11*), 1472-1473. doi: 10.1016/j.jocn.2010.02.026

Mariager, T. P., Madsen, P. V., Ebbehoj, N. E., Schmidt, B., & Juhl, A. (2013). Severe adverse effects related to dermal exposure to a glyphosate-surfactant herbicide. Cli*n Toxicol (Phila), 51(2)*, 111-113. doi: 10.3109/15563650.2013.763951

McDuffie, H. H., Pahwa, P., McLaughlin, J. R., Spinelli, J. J., Fincham, S., Dosman, J. A., . . . Choi, N. W. (2001). Non-Hodgkin's lymphoma and specific pesticide exposures in men: cross-Canada study of pesticides and health. Can*cer Epidemiol Biomarkers Prev, 10(11*), 1155-1163.

Mesnage, R., Bernay, B., & Seralini, G. E. (2013). Ethoxylated adjuvants of glyphosate-based herbicides are active principles of human cell toxicity. Tox*icology, 313(2*-3), 122-128. doi: 10.1016/j.tox.2012.09.006

Mills, K., Blair, A., Freeman, L., Sandler, D., & Hoppin, J. (2009). Pesticides and Myocardial Infarction Incidence and Mortality Among Male Pesticide Applicators in the Agricultural Health Study. Ame*rican Journal of Epidemiology, 170(7)*, 892-900. doi: 10.1093/aje/kwp214

Mink, P. J., Mandel, J. S., Lundin, J. I., & Sceurman, B. K. (2011). Epidemiologic studies of glyphosate and non-cancer health outcomes: a review. Reg*ul Toxicol Pharmacol, 61(2)*, 172-184. doi: 10.1016/j.yrtph.2011.07.006

Mink, P. J., Mandel, J. S., Sceurman, B. K., & Lundin, J. I. (2012). Epidemiologic studies of glyphosate and cancer: A review. Reg*ulatory Toxicology and Pharmacology, 63(3)*, 440-452. doi: 10.1016/j.yrtph.2012.05.012

Mink, P. J., Mandel, J. S., Sceurman, B. K., & Lundin, J. I. (2012). Epidemiologic studies of glyphosate and cancer: a review. Reg*ul Toxicol Pharmacol, 63(3)*, 440-452. doi: 10.1016/j.yrtph.2012.05.012

Montgomery, M. P., Kamel, F., Saldana, T. M., Alavanja, M. C., & Sandler, D. P. (2008). Incident diabetes and pesticide exposure among licensed pesticide applicators: Agricultural Health Study, 1993-2003. Am *J Epidemiol, 167(10*), 1235-1246. doi: 10.1093/aje/kwn028

Motojyuku, M., Saito, T., Akieda, K., Otsuka, H., Yamamoto, I., & Inokuchi, S. (2008). Determination of glyphosate, glyphosate metabolites, and glufosinate in human serum by gas chromatography-mass spectrometry. J C*hromatogr B Analyt Technol Biomed Life Sci, 875(2)*, 509-514. doi: 10.1016/j.jchromb.2008.10.003

Nordstrom, M., Hardell, L., Magnuson, A., Hagberg, H., & Rask-Andersen, A. (1998). Occupational exposures, animal exposure and smoking as risk factors for hairy cell leukaemia evaluated in a case-control study. Bri*tish Journal of Cancer, 77(11*), 2048-2052. doi: 10.1038/bjc.1998.341

Orsi, L., Delabre, L., Monnereau, A., Delval, P., Berthou, C., Fenaux, P., . . . Clavel, J. (2009). Occupational exposure to pesticides and lymphoid neoplasms among men: results of a French case-control study. Occ*upational and Environmental Medicine, 66(5)*, 291-298. doi: 10.1136/oem.2008.040972

Pahwa, P., Karunanayake, C. P., Dosman, J. A., Spinelli, J. J., McDuffie, H. H., & McLaughlin, J. R. (2012). Multiple myeloma and exposure to pesticides: a Canadian case-control study. J A*gromedicine, 17(1)*, 40-50. doi: 10.1080/1059924x.2012.632339

Peixoto, F. (2005). Comparative effects of the Roundup and glyphosate on mitochondrial oxidative phosphorylation. Che*mosphere, 61(8)*, 1115-1122. doi: 10.1016/j.chemosphere.2005.03.044

Potrebic, O., Jovic-Stosic, J., Vucinic, S., Tadic, J., & Radulac, M. (2009). [Acute glyphosate-surfactant poisoning with neurological sequels and fatal outcome]. Voj*nosanit Pregl, 66(9)*, 758-762.

Ptok, M. (2009). [Dysphonia following glyphosate exposition]. Hno, *57(11)*, 1197-1202. doi: 10.1007/s00106-009-1962-8

Pushnoy, L. A., Avnon, L. S., & Carel, R. S. (1998). Herbicide (Roundup) pneumonitis. Che*st, 114(6)*, 1769-1771.

Roberts, D. M., Buckley, N. A., Mohamed, F., Eddleston, M., Goldstein, D. A., Mehrsheikh, A., . . . Dawson, A. H. (2010). A prospective observational study of the clinical toxicology of glyphosate-containing herbicides in adults with acute self-poisoning. Cli*n Toxicol (Phila), 48(2)*, 129-136. doi: 10.3109/15563650903476491

Ruder, A. M., Waters, M. A., Butler, M. A., Carreón, T., Calvert, G. M., Davis-King, K. E., . . . Group, B. C. C. S. (2004). Gliomas and farm pesticide exposure in men: the upper midwest health study. Arc*h Environ Health, 59(12)*, 650-657.

Rull, R. P., Ritz, B., & Shaw, G. M. (2006). Neural tube defects and maternal residential proximity to agricultural pesticide applications. Ame*rican Journal of Epidemiology, 163(8)*, 743-753. doi: 10.1093/aje/kwj101

Sampogna, R. V., & Cunard, R. (2007). Roundup intoxication and a rationale for treatment. Cli*n Nephrol, 68(3)*, 190-196.

Sanin, L. H., Carrasquilla, G., Solomon, K. R., Cole, D. C., & Marshall, E. J. (2009). Regional differences in time to pregnancy among fertile women from five Colombian regions with different use of glyphosate. J T*oxicol Environ Health A, 72(15*-16), 949-960. doi: 10.1080/15287390902929691

Sathyanarayana, S., Basso, O., Karr, C., Lozano, P., Alavanja, M., Sandler, D., & Hoppin, J. (2010). Maternal Pesticide Use and Birth Weight in the Agricultural Health Study. Jou*rnal of Agromedicine, 15(2)*, 127-136. doi: 10.1080/10599241003622699

Sato, C., Kamijo, Y., Yoshimura, K., & Ide, T. (2011). Aseptic meningitis in association with glyphosate-surfactant herbicide poisoning. Cli*n Toxicol (Phila), 49(2)*, 118-120. doi: 10.3109/15563650.2011.552065

Savitz, D. A., Arbuckle, T., Kaczor, D., & Curtis, K. M. (1997). Male pesticide exposure and pregnancy outcome. Am *J Epidemiol, 146(12)*, 1025-1036.

Sawada, Y., Nagai, Y., Ueyama, M., & Yamamoto, I. (1988). Probable toxicity of surface-active agent in commercial herbicide containing glyphosate. Lan*cet, 1(85*80), 299.

Slager, R. E., Poole, J. A., LeVan, T. D., Sandler, D. P., Alavanja, M. C. R., & Hoppin, J. A. (2009). Rhinitis associated with pesticide exposure among commercial pesticide applicators in the Agricultural Health Study. Occ*upational and Environmental Medicine, 66(11)*, 718-724. doi: 10.1136/oem.2008.041798

Slager, R. E., Simpson, S. L., Levan, T. D., Poole, J. A., Sandler, D. P., & Hoppin, J. A. (2010). Rhinitis associated with pesticide use among private pesticide applicators in the agricultural health study. J T*oxicol Environ Health A, 73(20)*, 1382-1393. doi: 10.1080/15287394.2010.497443

Sorensen, F. W., & Gregersen, M. (1999). Rapid lethal intoxication caused by the herbicide glyphosate-trimesium (Touchdown). Hum *Exp Toxicol, 18(12)*, 735-737.

Sribanditmongkol, P., Jutavijittum, P., Pongraveevongsa, P., Wunnapuk, K., & Durongkadech, P. (2012). Pathological and toxicological findings in glyphosate-surfactant herbicide fatality: a case report. Am *J Forensic Med Pathol, 33(3)*, 234-237. doi: 10.1097/PAF.0b013e31824b936c

Stella, J., & Ryan, M. (2004). Glyphosate herbicide formulation: a potentially lethal ingestion. Em*erg Med Australas, 16(3)*, 235-239. doi: 10.1111/j.1742-6723.2004.00593.x

Talbot, A. R., Shiaw, M. H., Huang, J. S., Yang, S. F., Goo, T. S., Wang, S. H., . . . Sanford, T. R. (1991). Acute poisoning with a glyphosate-surfactant herbicide ('Roundup'): a review of 93 cases. Hum *Exp Toxicol, 10(1)*, 1-8.

Valcin, M., Henneberger, P. K., Kullman, G. J., Umbach, D. M., London, S. J., Alavanja, M. C. R., . . . Hoppin, J. A. (2007). Chronic bronchitis among nonsmoking farm women in the agricultural health study. Jou*rnal of Occupational and Environmental Medicine, 49(5)*, 574-583. doi: 10.1097/JOM.0b013e3180577768

Wang, G., Fan, X. N., Tan, Y. Y., Cheng, Q., & Chen, S. D. (2011). Parkinsonism after chronic occupational exposure to glyphosate Par*kinsonism Relat Disord (V*ol. 17, pp. 486-487). England.

Wang, Y., Wu, B., Lian, H., & Shi, C. (2012). [Determination of glyphosate in heart blood of corpse by ion chromatography]. Se *Pu, 30(4)*, 419-422.

Weng, S. F., Hung, D. Z., Hu, S. Y., Tsan, Y. T., & Wang, L. M. (2008). Rhabdomyolysis from an intramuscular injection of glyphosate-surfactant herbicide. Cli*n Toxicol (Phila), 46(9)*, 890-891. doi: 10.1080/15563650802286731

Whyatt, R. M., Rauh, V., Barr, D. B., Camann, D. E., Andrews, H. F., Garfinkel, R., . . . Perera, F. P. (2004). Prenatal insecticide exposures and birth weight and length among an urban minority cohort. Env*iron Health Perspect, 112(10*), 1125-1132.

Wu, J. Y., Chang, S. S., Tseng, C. P., Deng, J. F., & Lee, C. C. (2006). Parenteral glyphosate-surfactant herbicide intoxication. Am *J Emerg Med, 24(4)*, 504-506. doi: 10.1016/j.ajem.2005.12.002

Yiin, J. H., Ruder, A. M., Stewart, P. A., Waters, M. A., Carreón, T., Butler, M. A., . . . Group, B. C. C. S. (2012). The Upper Midwest Health Study: a case-control study of pesticide applicators and risk of glioma. Env*iron Health, 11, 3*9. doi: 10.1186/1476-069X-11-39

Yoo, S., & BS., K. (2010). Glyphosate Induced Severe Tublulo-Interstitial Nephritis Requiring Hemodialysis. The *Korean Journal of Nephrology, 1*58-161.

Zouaoui, K., Dulaurent, S., Gaulier, J. M., Moesch, C., & Lachatre, G. (2013). Determination of glyphosate and AMPA in blood and urine from humans: about 13 cases of acute intoxication. For*ensic Sci Int, 226(1*-3), e20-25. doi: 10.1016/j.forsciint.2012.12.010

Appendix 1

Table A: Glyphosate Formulations Identified by the U.S. Forest Service (Diamond, 2011)

Formulation Name	Supplier	EPA Reg. No.	Form	Salt	%a.i.	Surfactant	Other
Accord	Monsanto	524-326	L	IPA	41.5%		Aq
Accord Concentrate	DowAgro Sciences	62719-324	L	IPA	53.8%		
Accord SP	DowAgro Sciences	62719-322	L	IPA	41%	X	No longer available
Accord XRT	DowAgro Sciences	62719-517	L	IPA	53.6%	X-[10]	
Accord XRT II	DowAgro Sciences	62719-556	L	DMA	50.2%	Inferred	
Aqua Star	Albaugh, Inc.	42750-59	L	IPA	53.8%	?[7]	
AquaMaster (a.k.a. Export and Rodeo)	Monsanto	524-343	L	IPA	53.8%		Aq
AquaNeat	Riverdale	228-365	L	IPA	53.8%		Aq
Buccaneer	Tenkoz Inc	55467-10	L	IPA	41.0%	X	
Buccaneer Plus	Tenkoz Inc	55467-9	L	IPA	41.0%	X	
Cornerstone	Winfield Solutions Agrisolutions	1381-191 71368-20-	L	IPA	41.0%	X	
Cornerstone Plus	Winfield Solutions	1381-192	L	IPA	41.0%	?	
Credit Extra	Nufarm	71368-65	L	Am K	17.86% 16.26%	X POEA?	
Credit Systemic Extra	Nufarm	71368-20	L	IPA	41.0%	X POEA?	
Diamondback	EZ-Ject	83220-1	Sh	IPA	83.5%		Injection
DuraMax	DowAgro Sciences	62719-556	L	DMA	50.2%	Inferred	
Durango (GF-1279)	DowAgro Sciences	62719-517	L	IPA	53.6%	X-[10]	
Durango DMA (GF-1280)	DowAgro Sciences	62719-556	L	DMA	50.2%	Inferred	
Eliminator [4,6]	Gro Tec, Inc	71995-27	L	IPA	41.0%	X	
Foresters' Non Selective	Riverdale	228-381	L	IPA	53.8%	None[8]	
Glyphogan	Makhteshim Agan	66222-105	L	IPA	41.0%	Inferred	
Glyphomax 41 Plus [4]	DowAgro Sciences	62719-322	L	IPA	41.0%	Inferred	
Glyphomax XRT	DowAgro Sciences	62719-517	L	IPA	53.6%	X-[10]	
Gly Star Plus	Albaugh Inc	42750-61	L	IPA	41.0%	X	
Glyphosate VMF	DuPont	352-609	L	IPA	53.8%		Cancelled ?
Glyphosate 41 Plus	CropSmart	42750-61-	L	IPA	41.0%	?	
GlyphoMate 41 or Pronto	PBI/Gordon Corporation	2217-847	L	IPA	41.0%	X	
Glyfos Aquatic	Cheminova A/S	4787-34	L	IPA	53.8%		Aq
Glyfos X-TRA	Cheminova A/S	4787-23	L	IPA	41.0%	X 15%[6]	
Glypro	DowAgro Sciences	62719-324	L	IPA	53.8%		
Gly-4 Plus	Universal Crop Protection Alliance	72693-1	L	IPA	41.0%	X	
Helosate Plus	Helm Agro US,	74530-4	L	IPA	41.0%	Inferred	

Formulation Name	Supplier	EPA Reg. No.	Form	Salt	%a.i.	Surfactant	Other
Hi-yield Killzall	Voluntary Purchasing	67760-49-7401		IPA	53.8%		Aq
Honcho (RoundupOriginal)	Monsanto	524-445	L	IPA	41.0%	X	
Honcho Plus	Monsanto	524-454	L	IPA	41.0%	X	
Imitator Plus	Drexel Chemical	19713-526	L	IPA	41.0%	?	
KGro Grass and Weed	Swiss Farms Pdts	71995-27-	L	IPA	1.92%		
Mirage	Loveland Products	34704-866	L	IPA	41.0%	Inferred	
Ranger Pro	Monsanto	524-517	L	IPA	41.0%	X	
RapidFire	DowAgro Sciences	62719-556	L	DMA	50.2%	Inferred	
Rattler	Monsanto	524-445-ZE-	L	IPA	41.0%		
Razor	Nufarm	228-366 [1]	L	IPA	41.0%	X 8%[8]	
Razor Pro	Nufarm	228-366 [1]	L	IPA	41.0%	X 14%[8]	
Rodeo	DowAgro Sciences	62719-324	L	IPA	53.8%		
Roundup Original Max	Monsanto	524-539 [3]	L	K	48.7%	X	
Roundup Pro	Monsanto	524-475 [2]	L	IPA	41.0%	X 14.5%	
Roundup Pro Concen.	Monsanto	524-539 [3]	L	IPA	50.2%	X 13%	
	Monsanto	524-505	G	Am	71.4%	X	
Roundup ProMax	Monsanto	524-579	L	K	48.7%	X	
Roundup UltraMax	Monsanto	524-512	L	IPA	50.2%	X	
Roundup UltraDry	Monsanto	524-504	G	Am	71.4%	X 25%	
Roundup WeatherMax	Monsanto	524-537	L	K	48.8%	X	
RT 3	Monsanto	524-544	L	K	48.8%	X	

[1] Razor and Razor Pro appear to have the same EPA Registration number but the formulations are different.

[2] Based on the EPA master product label, this registration number applies to the following brand names: Roundup Ultra Herbicide; Roundup Ultra RT Herbicide; Roundup Pro Herbicide; Roundup Original II CA; MON 77360 Herbicide; Roundup W Herbicide; Gly 41 Herbicide.

[3] Based on the Product Labels and MSDSs, Roundup Original Max and Roundup Pro Concentrate have the same EPA registration number but contains different salts of glyphosate.

[4] Need specimen label. The EPA labels are not clear (are ambiguous) in terms of the formulation(s) covered.

[5] MSDS cannot be located, including searches of http://www.msdsonline.com and http://www.cdms.net.

[6] From Lajmanovich et al. 2003 but not specifically identified as Glyphos Plus.

[7] Bringolf et al. (2007) state that Aqua Star does not contain the MON 0808 POEA surfactant. It is not clear whether or not this formulation contains a less toxic surfactant.

[8] Information confirmed by Nufarm (Ehresman 2010a).

[9] Dow (Fonseca 2010a) has indicated that Accord SP (EPA Reg. No. 62719-322) is not longer commercialized.

[10] Based on information provided by Dow AgroSciences (Fonseca 2010a)

Key:

Form: L=Liquid; G=Granular; Sh=Shells.

Salt: Am=Ammonium salt: DMA=Dimethylamine salt; IPA=Isopropylamine salt; K=Potassium salt;

Other: Aq=Aquatic application; Inj=Injection.

Formulations containing herbicides other than glyphosate as the a.e. are not included.

Table B: Summary of References for the Medical Literature Search		
Study	**Author**	**Summary**
1. Rosen's Emergency Medicine: Concepts and Clinical Practice. 6th ed.	Aaron CK. (2006)	Glyphosate inhibits the enzyme 5-enolpyruvyl-shikimic-3-phosphate-synthase in plants; however, mammals do not have this enzyme.
2. Annual Report	American Association of Poison Control Centers (2011)	According to the American Association of Poison Control data in 2011, glyphosate ranked first with 3,570 exposures among reported human exposures to herbicides (total of 8377); 90% were unintentional.
3. Skin Toxicity from Glyphosate-Surfactant Formulation	Amerio P., Motta A.et al. (2004)	A 78 year old woman presented with extensive chemical burns on her back, knees and legs caused by accidental contact with a glyphosate-surfactant formulation. Sheets of necrotic epidermis had sloughed, leaving extensive erosions. Bullae were present on the dorsum of the feet.
4. Glyphosate poisoning.	Bradberry SM. (2004)	The mechanisms of toxicity of glyphosate formulations are complicated. Not only is glyphosate used as five different salts but commercial formulations of it contain surfactants, which vary in nature and concentration. Ingestion of >85 mL of the concentrated formulation is likely to cause significant toxicity in adults.
5. Extreme hyperkalemia in a patient with a new glyphosate potassium herbicide poisoning: report of a case.	Bando H., Murao Y, (2010)	Ingestion of Roundup Maxload which contains high concentration of glyphosate potassium can cause extreme hyperkalemia with cardiac toxicity and metabolic acidosis.
6. Clinical impact of upper gastrointestinal tract injuries in glyphosate-surfactant oral intoxication.	Chang C.Y., (1999)	Authors studied lesions in gastrointestinal tract of 50 patients with glyphosate-surfactant oral ingestion as a suicide attempt. They found that esophageal injury was seen in 68% of the patients; gastric injury in 72%, and duodenal injury in 16%.
7. Refractory cardiopulmonary failure after glyphosate surfactant intoxication: a case report.	Chang CB, Chang CC (2009)	Patient ingested about 400 mL of concentrated glyphosate developed shock, respiratory failure, hyperkalemia, and acidosis. In spite of comprehensive supportive treatment, patient died 3 days after admission.
8.The epidemiology of glyphosate-surfactant herbicide poisoning in Taiwan, 1986-2007: a poison center study.	Chen YJ, Wu ML, Deng JF, Yang CC (2009)	A retrospective analysis of all GlySH exposures reported to the Taiwan National Poison Control Center between 1986 and 2007. Irritation of the oral mucous membrane and gastrointestinal tract was the most frequently reported effect. Other effects recorded were pulmonary dysfunction, oliguria, metabolic acidosis, hypotension, leukocytosis and fever. Cardiovascular collapse and respiratory failure were two major cause of fatality (Y. J. Chen, Wu, Deng, & Yang, 2009).
9. Glyphosate Human Health and Ecological Risk Assessment (USDA)	Durkin PR (2011)	Authors mentioned that there were various concentrations of POEA surfactant, glyphosate salts and other ingredients in different glyphosate products and the resulting adverse health effects may be different.
10. Handbook of Pesticide Toxicology, 2nd edition (Inhibitors of Aromatic Acid Biosynthesis).	Farmer D., (2001)	Glyphosate contains a carbon and phosphorous moiety but it is not a cholinesterase inhibitor and does not affect the nervous system in the same way as organophosphate insecticides
11. Pesticide-Associated Pemphigus Vulgaris	Fisher KR., et al., (2008)	Described a patient who developed pemphigus vulgaris (PV) on his body and extremities, after an occupational exposure to fumes of burning empty glyphosate drums. PV is an autoimmune skin lesions characterized by bullae that rupture quickly and progress to crusted erosions.
12. **Determination of the herbicide glyphosate and its metabolite in**	Hori, Y.	Authors described the method for determining glyphosate and its metabolites by GC-MS.

biological specimens by gas chromatography-mass spectrometry. A case of poisoning by roundup herbicide		
13. Herbicide roundup intoxication: successful treatment with continuous renal replacement therapy.	Hour BT., Belen C., Zar T., Lien YH., (2012)	Roundup toxicity is mainly due to surfactant, which interferes with the mitochondrial wall, destroying the proton gradient required for energy production. Patient develops cardiogenic shock, lactic acidosis and multiorgan failure. Early administration of hemodialysis would be the treatment of choice (Hour, Belen, Zar, & Lien, 2012).
14. Erythema multiforme like eruption due to an irritant contact dermatitis	**Heras-Mendaza F., et al. (2008)**	A 37-year –old female was exposed to glyphosate herbicide (Touchdown Premium) when the backpack containing the herbicide broke and wet her clothing. She suffered from the irritant contact dermatitis, followed by erythemato-purpuric plaques developed on the upper extremities, on the abdomen, axilla and groin.
15. Glyphosate-surfactant herbicide products containing glyphosate potassium salt can cause fatal hyperkalemia if ingested in massive amounts.	Kamijo Y, Mekari M, (2012)	A 69-year old female ingested about 500 mL of Roundup Maxload contains 48% glyphosate potassium developed severe hyperkalemia and refractory ventricular tachycardia. It was considered that hyperkalemia was caused by Roundup Maxload which contains potassium 2.6 mEq/mL. Endoscopy showed pharyngeal edema, esophageal and gastric erosions.
16. Early continuous dialysis in acute glyphosate-surfactant poisoning.	Knežević V. (2012)	A 36-year old male took about 300 ml of glyphosate-surfactant, six hours later he developed hypotension, oliguria and renal failure. Hemodialysis brought the complete recovery of renal function on the 5th day (Knezevic et al., 2012).
17. Clinical presentations and prognostic factors of a glyphosate-surfactant herbicide intoxication	Lee H.L., Chen K.W., Chi C.H., Huang J.J., Tsai L.M., (2000)	Retrospective review of 131 cases in Taiwan University hospital. The most common symptoms included sore throat (79.5%), and nausea with or without vomiting (73.8%). The most common laboratory findings were leucocytosis (68.0%), low serum bicarbonate (48.1%), and acidosis (35.8%).
18. The early prognostic factors of glyphosate-surfactant intoxication.	Lee C-H, Shih CP, Hsu KH, Hung DZ, Lin CC. (2008)	GlySH poisoning is multiorgan toxicity. Metabolic acidosis, hyperkalemia, respiratory distress needing intubation, tachycardia, and elevated serum creatinine level are useful prognostic factors for predicting GlySH mortality.
19. Severe adverse effects related to dermal exposure to a glyphosate-surfactant herbicide	Mariager TP., Madsen PV ., (2013)	A 43-year old man diluted the glyphosate-surfactant herbicide with water and shook the bottle; the contents accidentally sprayed on him. He did not wash the exposed areas. The next day he developed local swelling, bullae and exuding wounds on right hand, arm, upper arm and axilla regions. Soon it changed into second degree skin necrosis with detachment of the epidermis. In addition he had touched his face with contaminated hands resulting in a peri-orbital edema. Nerve conduction study (NCS) showed reduced nerve conduction in distal axons on the medial, ulnar and radial nerves. Imaging revealed edema of the soft tissue and osteopenia of carpal bones.
20. Ethoxylated adjuvants of glyphosate-based herbicides are active principles of human cell toxicity.	Mesnage R, Bernay B, Séralini GE. (2012)	All formulations are more toxic than glyphosate. Polyethoxylated tallowamine POE-15 appears to be the most toxic principle against human cells (cell membrane disruption and necrosis). Since pesticides are always used with adjuvants that could change their toxicity, it is necessary to assess the toxicity of whole formulations in addition to the active ingredient (Mesnage, Bernay, & Seralini, 2013).
21. Glyphosate–surfactant herbicide-induced reversible encephalopathy.	Malhotra R.C., Ghia DK.(2010)	A 71-year-old male who attempted suicide with GlySH developed a prolonged (clinically unresponsive for more than 7 days, demonstrated with electroencephalogram) but reversible encephalopathy suggestive of the acute central nervous system (CNS) toxicity of the product.

22. Glyphosate based pesticides affect cell cycle regulation.	Marc J. et al., (2004)	Glyphosate based pesticide products disrupt cell-cycle control mechanisms, which may be relevant for cancer as well as noncancer health outcomes.
23. Comparative effects of the Roundup and glyphosate on mitochondrial oxidative phosphorylation.	Peixoto F (2005).	The potential toxicity of the herbicide Roundup and its fundamental substance (glyphosate) was tested in isolated rat liver mitochondria. Roundup interferes electron transfer (by partially inhibiting mitochondrial complexes II and III) and depresses ATPase activity, while glyphosate used in the same concentrations does not induce any significant effect.
24. Acute glyphosate-surfactant poisoning with neurological sequels and fatal outcome	Potrebić O, Jović-Stosić J, (2009)	A 56 year old woman ingested about 500 mL of herbicide containing glyphosate isopropylamine salt developed hypotension, hyperkalemia, respiratory and renal failure, coma and had a lethal outcome. MRI revealed bilateral extensive white matter lesions of the brain stem and Pons.
25. Herbicide (Roundup) pneumonitis.	Pushnoy LA, Avnon LS, Care RS (1998).	A 42-year old worker had inhaled Roundup while cleaning the spraying device in a confined space. He developed shortness of breath, irritative cough, dizziness and hemoptysis. Otolaryngology evaluation showed signs of burns in the mucosal membranes of the pharynx and larynx. Chest X-ray showed acute massive pneumonitis.
26. Dysphonia following glyphosate exposition	Ptok M (2009)	A 26-year-old teacher who used glyphosate formulation correctly but suffered from severe dysphonia after few hours. Laryngoscopy revealed decreased vocal fold mobility suggesting innervation impairment. The symptoms resolved spontaneously 6 weeks later and vocal fold mobility returned to normal.
27. A prospective observational study of the clinical toxicology of glyphosate-containing herbicides in adults with acute self-poisoning	Roberts DM. et al (2010)	601 cases of intentional ingestion between 2002- 2007 in two hospitals in Sri Lank were followed. 86% of patients had mild symptoms and signs such as nausea, vomiting, diarrhea, abdominal pain, transient hypotension, and tachypnea (respiratory rate >25/minute). 5.5% of patients were in moderate to severe condition with depressed level of consciousness, had respiratory failure and severe hypotension (mean arterial blood pressure <70 mmHg). 3.2% of cases were fatal (median time to death was 20 hours). Glyphosate plasma concentration >734 μg/mL was the best predictor of fatality. Glyphosate product was rapidly absorbed from the GI tract, followed first-order elimination with a half-life ranged from (2.7-3.6) hours.
28. Pathological and toxicological findings in glyphosate-surfactant herbicide fatality: a case report.	Sribanditmongkol P, Jutavijittum P, (2012)	A 37-year-old woman intentionally ingested approximately 500 mL of concentrated Roundup formulation (41% glyphosate as the isopropylamine salt and 15% polyoxyethylene amine). The postmortem examination revealed hemorrhagic areas in the gastric mucosa of anterior fundus and the small intestines had marked dilatation and thin walls. The glyphosate levels of serum and gastric content were 3.05 and 59.72 mg/mL, respectively.
29. Aseptic meningitis in association with glyphosate-surfactant herbicide poisoning.	Sato C, et al (2011)	Patient demonstrated Kernig's sign and significant neck stiffness with rigidity of the extremities as well as consciousness disturbance and fever (38.4°C). Investigations of cerebrospinal fluid (CSF) revealed the presence of glyphosate (122.5 μg/mL), significant elevation of IL-6 (394 μg/mL), and pleocytosis (32 cells/μL) with monocyte dominance. All bacteriological and virological tests were negative.
30. Glyphosate herbicide formulation: A potentially lethal ingestion.	Stella J, Ryan M. (2004)	Although glyphosate is generally regarded as minimally toxic, severe poisoning with glyphosate formulation may be refractory even to the most intensive supportive care. The triad of pulmonary edema, metabolic acidosis and hyperkalemia indicates poor outcome. Polyethoxylated tallowamine (POEA) toxicity can cause gastric pain, pulmonary edema, impaired consciousness and hemolysis. Glyphosate alone can

		also cause gastrointestinal erosions, renal toxicity, metabolic acidosis and central nervous system effects.
31. Roundup intoxication and a rationale for treatment.	Sampogna R.V., Cunard R. (2007)	Patient developed acute renal failure with oliguria after ingestion of Roundup. His condition improved rapidly and renal function returned to normal with hemodialysis treatment (Sampogna & Cunard, 2007).
32. Rapid lethal intoxication caused by the herbicide glyphosate-trimesium (Touchdown).	Sorensen FW, Gregersen M., (1999)	A 6-year-old boy who accidentally ingested a mouthful of glyphosate-trimesium died within few hours. The same happened to a 34-year-old woman who intentionally ingested approximately 150 ml of glyphosate-trimesium. The speed of which death occurs is much more rapid than lethal intoxications with glyphosate (isopropylamine salt), also known as 'Roundup'.
33. Acute Poisoning with a Glyphosate-Surfactant Herbicide ('Roundup'): A Review of 93 Cases	Talbot (1991)	The average amount of the 41% solution of glyphosate surfactant herbicide ingested by lethal cases was 184 ± 70 ml (range 85-200 ml). There were erosion of gastrointestinal tract, pulmonary, renal and central nervous system dysfunction. Deaths followed refractory hypotension or pulmonary edema.
34. Glyphosate Induced Severe Tubulointerstitial Nephritis Requiring Hemodialysis.	Yoo SH, Kim BS, Lee HY., (2010)	Reported the first case of glyphosate induced severe tubulointerstitial nephritis (not secondary to cardiovascular collapse) requiring hemodialysis. Kidney biopsy revealed drug-induced nephrotoxic injury. Patient had ingested about 90 mL of the product.
35. Parkinsonism after chronic occupational exposure to glyphosate	Wang G., Fan X-N., (2011)	A 44 year old woman who worked exclusively at the glyphosate production division for 3 years, 50 hours each week, wearing only basic PPE (gloves or face mask) was diagnosed with Parkinsonism syndrome. She had weakness, dizziness, and blurred vision. She also had a resting tremor, global akinesia and rigidity in all four limbs. MRI revealed bilateral hypotense lesions in the globus pallidus, the substantia nigra and in the cerebral peduncle.
36. Determination of glyphosate in heart blood of corpse by ion chromatography.	Wang Y., et al., (2012)	Ion chromatography is a simple, sensitive and accurate method to prove that the patient had a glyphosate poisoning.
37. Rhabdomyolysis from an intramuscular injection of glyphosate-surfactant herbicide.	Weng SF, Hung DZ, Hu SY, Tsan YT, Wang LM (2008)	Authors described the Rhabdomyolysis (destruction of muscle cells) in the upper limb due to intramuscular injection with the glyphosate product in a suicide attempt (Weng, Hung, Hu, Tsan, & Wang, 2008).
38. Determination of glyphosate and AMPA in blood and urine from humans: About 13 cases of acute intoxication.	Zouaoui K, Dulaurent S, Gaulier JM, Moesch C, Lachâtre G. (2013)	In mild to moderate intoxications blood glyphosate concentrations had a mean value of 61mg/L (range 0.6-150mg/L), in severe intoxication cases, the blood glyphosate concentrations were around 838mg/L and in fatal cases 4146mg/L (range 690-7480mg/L).

Appendix 2

Human Incidents	Chemical: Glyphosate	PC Code: 103601, 103603, 103604, 103605, 103607, 103608, 103613, and 417300

Incident Package Report	Incident Date	Location	Reg Number	Product Name	PC Code	Exposure Severity	Incident Description
019417 - 00001	1/1/2008	FL	000524-00445	ROUNDUP HERBICIDE	103601	MODERATE	A 74 year old male ingested 1/2 gallon of Roundup Concentrate. He experienced vomiting, diarrhea and high blood pressure
019542 - 00001	1/1/2008	CA	071995-00032	ROUNDUP WEED AND GRASS KILLER READY TO USE PLUS	103601	MODERATE	The caller states that she is a medical doctor calling on behalf of her friend who has been suffering from Roundup poisoning for years. The caller states that her friend self diagnosed the Roundup poisoning. The woman is being treated for chronic fatigue syndrome and was prescribed to give herself heparin weekly for the condition. She was giving herself heparin that was manufactured in China and it had a hyper sulfur content. She is the only person of her MD's patients who reacted adversely to the heparin getting skin pain and flushing. The patient also has history of asthma but is not compliant with any therapies for the asthma. The caller is not treating the woman. PCC confirmed the exposure was when the gardener sprayed the product outside her home.
019726 - 00001	3/1/2008	HI	000524-00445	ROUNDUP HERBICIDE	103601	MODERATE	Man was working with Roundup Herbicide unknown formulation about four weeks ago. He does not have the container to confirm the product ingredients. He stated while mixing the product he got some on his hands. He did not wash with soap and water until a few hours passed. The next day his hands were a reddish brown then light redness and the skin sloughed off. His hands are now discolored and sensitive. He has not seen a doctor. At the end of the conversation, he mentioned he is a chemist and works with chemicals. He usually does not get anything on his hands as he wears protective gloves.
019727 - 00001	6/3/2008	CA	000524-00475	ROUNDUP PRO	103601	MODERATE	A worker got overspray from Roundup PRO in his eyes about 1 0 days ago. He rinsed his eyes on the sight and has been to the eye doctor. He has been prescribed eye drops for the last 10 days but his eyes are red and still irritated. He is worried about

Incident Package Report	Incident Date	Location	Reg Number	Product Name	PC Code	Exposure Severity	Incident Description
							long term damage to his eyes or if there is something else he should be doing. Follow up indicated that one of the problems with eye drops is an allergic reaction to the drops. There are also some nasal symptoms, so an allergy to the eye drops is likely. He went to MD who advised him to stop using the drops.
019740 - 00001	5/7/2008	SILER CITY, NC	004787-00023	GLYFOS X-TRA	103601	MODERATE	A 36 year old male reports product was sprayed in his face and nose due to the fact that he claimed his sprayer was not attached correctly. There was no skin irritation; however, he reportedly started getting a cough, nasal discharge and a fever the next day. After examination by a doctor, caller reports symptoms were due to pneumonia. He was given antibiotics.
019741 - 00001	6/24/2008	NC	004787-00023	GLYFOS X-TRA	103601	MODERATE	A 51 year old male had product blown back on him by wind as he applied it. The product got primarily his face, head, arms and legs. Approximately 12 hours later, this man reportedly had a blotchy rash all over his head, arms, back, legs and chest with welts on his back and side. After an examination by a doctor, caller states husband was diagnosed with poison oak.
019746 - 00001	5/7/2008	HEATH, OH	004787-00023	ACE READY-TO-USE WEED & GRASS KILLER 2	103601	MODERATE	A 73 year old female reportedly got some product on her shoes. After wearing these same shoes the following Monday, caller noticed her feet were red and burning. Following soaking her feet in apple cider vinegar, caller claimed the skin on her feet was peeling off. Medical treatment was sought and caller was prescribed topical medication. Approximately three and 1/2 weeks later, caller reported having medical evaluation done and symptoms were resolving.
019772 - 00004	5/19/2008	READING, PA	062719-00322	GLYPRO PLUS HERBICIDE	103601	MODERATE	A 28 year old female states that on Tuesday she was spraying the dilute product and when she finished she removed the top of the sprayer and was hit "across her eyes" with the mist of the product. She didn't feel anything go into her eyes nor did she feel any discomfort at the time. She

Incident Package Report	Incident Date	Location	Reg Number	Product Name	PC Code	Exposure Severity	Incident Description
							states that last night while doing some trimming with her 'weed whacker' she got some grass in her eye. She couldn't get it out and so she went to the MD who rinsed her eye and gave her antibiotic eye drops. She is now wondering if the product could have also been involved with the irritation. She was asymptomatic before getting the grass in her eye.
019803 - 00001	6/11/2008	HI	034704-00890	KLEENUP PRO HERBICIDE	103601	MODERATE	An adult female was using product at her workplace. The product was mixed 2.5oz per gallon of water. The hose kept coming off and the diluted product saturated her gloves and pants. It was about 1 hour before she could rinse her skin. The next day she experienced decreased urine output, headache and nausea. Her headache and nausea resolved in 24 hrs. She went to MD to address her decreased urination and was diagnosed with a UTI. She was placed on antibiotic and her symptoms resolved.
019862 - 00002	5/7/2008	PA	071995-00032	ROUNDUP WEED AND GRASS KILLER READY TO USE	103601	MODERATE	Caller states that she was using Roundup Ready to Use yesterday morning for about 30 minutes and there was no noted exposure to the product except that she felt like she was breathing it in. She began to have symptoms of vomiting, bloody diarrhea.
019862 - 00007	5/27/2008	CA	071995-00023	ROUNDUP WEED & GRASS KILLER1 READY-TO-USE	103601	MODERATE	Caller states his spouse used a Roundup Ready to Use formulation one year ago. Some of the Roundup got onto her hands during the spraying. She did not wash her hands for several hours, until after the project was completed. No skin irritation or rash reported at the time of the exposure or near post-exposure. Husband calling the MRPC to see if the product is absorbed through the skin. His spouse has been diagnosed with squamous cell cancer. He wonders if this could be related to the use of Roundup with dermal exposure.
019862 - 00008	5/27/2008	IL	071995-00023	ROUNDUP WEED & GRASS KILLER1 READY-TO-USE	103601	MODERATE	Grandmother calling about her 5 year old granddaughter who, along with some friends, used a gallon of Roundup Weed and Grass Killer Ready to Use. They used the entire bottle on the weeds. There may have been some dermal exposure, but the children were bathed that day. There were no

Incident Package Report	Incident Date	Location	Reg Number	Product Name	PC Code	Exposure Severity	Incident Description
							complaints of a sore throat or nasal symptoms on the day of the exposure. The 5 year old female developed a cough and fever was diagnosed with pneumonia four days later. She is going to see a pulmonologist in one month. The caller would like to know if the child is poisoned. Caller states to her knowledge, none of the other children have been sick.
019862 - 00009	5/10/2008	IA	000524-00343	AQUAMASTER	103601	MODERATE	Mother calling about 24 year old son that was pulling out cattails by hand about 5-7days post herbicide treatment with Aquamaster mixed per direction with a nonionic surfactant. Unknown if he was wearing gloves at the time, but he did have on waders. Exposure was greater than six months ago. Since that time he has complained of sneezing, coughing, nasal drainage, gastrointestinal upset and headache. Man has been evaluated by PMD to rule out gastric reflux. He was also evaluated by ENT physician. Mother is calling today as she and son have noted a similar odor of product on son's breath recently. Man denies any oral exposure and questions inhalation of substance during time of dermal exposure. No recent contact with product.
019862 - 00010	5/15/2008	IN	000524-00445	ROUNDUP HERBICIDE	103601	MAJOR	Caller states that several years ago (2-3 years), she used a Roundup product or another herbicide to kill some poison ivy. She recalls that she mixed the product in a bucket, and some of the product may have splashed onto her leg(s). She developed a rash on her leg shortly after this exposure that she assumed was poison ivy. Then, she experienced tingling down her leg that she cannot get rid of. Her doctor told her that she had nerve damage. She had a hip and knee replaced and thought that may help the symptoms, but it didn't. Caller has accepted that there is nerve damage, but she is wondering if it could be due to this possible exposure.
019862 - 00012	6/2/2008	MN	071995-00032	ROUNDUP WEED & GRASS KILLER READY TO USE	103601	MODERATE	Caller states her 5 year old has had a reoccurring spider like rash on areas of his skin for about 1 month. Mother notices the rash after he has been

Incident Package Report	Incident Date	Location	Reg Number	Product Name	PC Code	Exposure Severity	Incident Description
							playing outside. The mother is worried that it could be due to the Roundup Weed and Grass Killer Ready To Use that her husband sprayed weeks ago. Her son was not around the area when it was sprayed or while it was still wet. The rash comes and goes and does not bother her son. No itching noted.
019862 - 00013	6/10/2008	MO	071995-00032	ROUNDUP WEED & GRASS KILLER READY TO USE	103601	MODERATE	An emergency department physician was calling, about a 68 year old male that presents with a history of sudden onset nausea and ataxia. No vomiting noted. The man stated that he had been spraying weeds with Roundup earlier today but does not think he got any of the product on his skin. The physician states she will be admitting the man for further workup to try and determine the cause of the symptoms.
019862 - 00015	6/8/2008	GA	000524-00445	ROUNDUP HERBICIDE	103601	MODERATE	Caller states he applied an unknown formulation of Roundup about a month or so ago while wearing gloves but short sleeves. It may have been windy, and the back spray may have gotten onto the exposed areas of his arms. Caller noticed red blotches from his wrists to his elbows shortly after applying the Roundup. The areas are not raised and they do not itch or hurt. He never recalls his arms being wet with the Roundup. He has been applying Cortisone 10 to both arms with no improvement. Caller has an appointment for MD to look at his arms tomorrow.
019862 - 00016	6/15/2008	MO	000524-00445	ROUNDUP HERBICIDE	103601	MODERATE	Caller states he sprayed Roundup Concentrate (unknown exact formulation) that was diluted 3 ounces to 1 gallon of water. A day or two later he pulled up the grass that he had sprayed. Immediately afterwards, he developed blotches and hives on his arms and trunk. He has been to the emergency room twice for treatment of hives and pruritis. He was given prednisone 10 mg the first time and hydroxyzine the second time. The emergency room didn't believe that his signs and symptoms were related to the Roundup, but rather that he was having an allergic reaction to something.

Incident Package Report	Incident Date	Location	Reg Number	Product Name	PC Code	Exposure Severity	Incident Description
019862 - 00017	6/21/2008	MO	000524-00445	ROUNDUP HERBICIDE	103601	MODERATE	Physician Assistant calling about a 38 year old female that came to the Emergency Department with complaints of malaise, weakness and appeared in poor health. She is jaundiced with acute onset hepatitis. Symptoms started four days earlier. The woman was working in her yard and mixed an unknown Roundup product and an Ortho Weed B Gone product together with her hands. She washed her hands later after she worked in the yard. The woman has associated her illness with this exposure. The attending MD and Physician Assistant do not think either product has anything to do with the woman's illness, but they wanted to double check possible toxicity. The woman is going to be admitted to the ICU.
019877 - 00001	6/1/2008	SHARPSBURG, GA		ROUND-UP 1.33 GALLON WEED KILLER WITH "PULL 'N SPRAY" FEATURE	103601	Unknown or No Effects	A 45 year old male was sprayed directly in the face with product. He was using a 1.33 Gallon container of Round-Up weed killer with a "Pull 'N Spray" delivery system, the pull handle snapped off with the contents under pressure. He got the product in his eyes, nose, and mouth. He does not feel that this product delivery system which is built into the packaging is safe and he believes that it should be considered for recall.
019910 - 00433	5/20/2008	PENNS GROVE, NJ	071995-00008-000239	TOTAL KILL WEED & GRASS KILLER READY-TO-USE	103601	MODERATE	Caller used this product to treat ivy in his yard. Two weeks later his 5 year old son had a seizure for the first time.
019952 - 00001	6/25/2008	IN	034704-00890	MAKAZE	103601	MODERATE	An adult male used the product and thought he may have ingested some of the product through the spray about 3-4 weeks ago. Caller said the product was diluted when he was using it. He has been seeing a MD because he has a heavy spot on his chest like a cough that never goes away. He had an X-ray done and everything was normal.
019978 - 00466	7/22/2008	CA	071995-00008-000239	TOTAL KILL WEED & GRASS KILLER READY-TO-USE	103601	MODERATE	An adult female used the product on the sidewalk. It was windy day and some product got on her arms and legs. Her right hand and leg were in contact with the product. Caller wiped the area with a dry paper towel and did not shower until the

Incident Package Report	Incident Date	Location	Reg Number	Product Name	PC Code	Exposure Severity	Incident Description
							next morning. Three days later she broke out in a light fine rash on both her arms and legs. She went to the MD who diagnosed it as an allergic reaction.
020042 - 00001	7/1/2008	IL	071995-00008	ROUNDUP READY-TO-USE WEED & GRASS KILLER	103601	MODERATE	Caller states she inadvertently sprayed Roundup Weed and Grass Killer RTU in her eye and then rinsed for about 5 minutes. She went to the ED for evaluation. She was diagnosed with an abrasion to the right eye and given an analgesic and antibiotic. She had an appt to follow up with her optometrist. The caller was not sure if the pressure from the spray caused the injury or if the sprayer hit her in the eye or just the Roundup.
020043 - 00001	7/1/2008	NY	071995-00020	ROUNDUP CONCENTRATE POISON IVY AND TOUGH BRUSH KILLER 1	103601	MODERATE	Wife calling about her husband who used Roundup Poison Ivy and Tough Brush Killer1 Concentrate that was diluted per label instructions. He also used an Ortho product around the same time. The man showered afterward. He started to feel sick that evening, and was worse the next day with chills, sweating and weakness. He was admitted to the hospital for treatment of pneumonia. The man was very dehydrated on admission. He complained of a severe headache and stomach pains. He had a CT scan of his lungs. Four days later, the physician called from the hospital to state that the man was admitted to the hospital for treatment of pneumonia.
020044 - 00001	7/1/2008	IA	071995-00017	ROUNDUP CONCENTRATE WEED & GRASS KILLER	103601	MODERATE	A 55 year old male was calling about his ongoing occupational dermal and inhalational exposure to Roundup Weed and Grass Killer Concentrate for three months. He complains of vertigo.
020048 - 00001	6/1/2008	MN	000524-00445	ROUNDUP HERBICIDE	103601	MODERATE	About one month ago a 52 year old female stated while outside treating weeds with an unspecified Roundup product, her hand had turned brown in color immediately after a dermal exposure to the product.
020065 - 00007	6/30/2008	HOT SPRINGS, AR	062719-00517	ACCORD XRT	103601	MODERATE	Caller is a company rep calling for an MD that is treating a patient that was using these three products in conjunction around 24 hour ago. Caller is not certain about the details of the exposure. Pt. was presenting with SOB and other symptoms, which the caller is unsure of. MD is inquiring

Incident Package Report	Incident Date	Location	Reg Number	Product Name	PC Code	Exposure Severity	Incident Description
							about the products. Pt. is currently being treated. Two days later, the patient's symptoms had resolved and he was back at work. It is unclear what the doctor's assessment revealed.
020083 - 00001	8/6/2008	CA	071995-00023	ROUNDUP WEED & GRASS KILLER1 READY-TO-USE	103601	MODERATE	Caller states a Roundup Ready to Use product was sprayed in his face and eyes while he was trying to adjust a clogged hose on the spray container. Man rinsed his eyes with water but did not elaborate on the method used. He complains that his left eye is still burning and the vision is blurred. On follow up, the man did rinse his eyes with water a little longer and then went to see his doctor who checked his eye and noted a small burn on the corneal surface. He was prescribed an ointment to use but he does not know its name. The doctor will follow up with him in 4-5 days.
020085 - 00001	7/1/2008	FL	071995-00032	ROUNDUP WEED & GRASS KILLER READY-TO-USE	103601	MODERATE	Caller states that about a month ago she was weeding with her sister and her sister was spraying Round Up Ready to Use. The caller began to have a burning sensation to her eye and at the time she was not sure if it was sweat in her eye or Round Up. She did go inside and wash off her face and then place a warm compress to her eye. No irrigation done at the time. The caller has been dealing with eye issues since that time. The caller reports that her eyes are red and tearing constantly. She first went to her PMD who prescribed antibiotic eye drops. Those drops did not work and she went to an ophthalmologist who prescribed prednisone for her eyes. That did not work and she has seen an allergist who prescribed eye drops which have also not resolved her symptoms.
020087 - 00001	6/1/2008	IL	071995-00032	ROUNDUP WEED & GRASS KILLER READY-TO-USE	103601	MODERATE	
020089 - 00001	8/22/2008	MO	071995-00007-059144	ELIMINATOR W & G KILLER SUPER CONCENTRATE	103601	MODERATE	Caller states her yard was sprayed with diluted Eliminator Super Concentrate on Friday morning. Later that day, her child was playing out in yard and could have accessed the area sprayed but it is not confirmed. The child became delusional and

Incident Package Report	Incident Date	Location	Reg Number	Product Name	PC Code	Exposure Severity	Incident Description
							hallucinated 30 minutes after playing outside. She was evaluated in the emergency department where a CT scan was done. Drug screens were all negative.
020090 - 00001	7/1/2008	OK	000524-00445	ROUNDUP HERBICIDE	103601	MODERATE	Caller states the rock area around her flowerbeds was sprayed with Roundup by lawn workers about 1.5 months ago. About an hour after spraying she walked on the rocks to access her hose while wearing socks and tennis shoes. When she turned on the hose, her feet got wet from the water. Worked in the yard for about an hour and then showered with soap and water. About 2 days later her foot broke out into a rash. The urgent care told her it was a topic dermatitis or eczema and a steroid cream was prescribed and used. She followed up with her PMD who referred her to the dermatologist because her symptoms were worsening. The dermatologist scraped the area and diagnosed her with a fungus infection.
020091 - 00001	7/1/2008	MO	000524-00475	GLY-41 HERBICIDE	103601	MODERATE	Caller states that about a month ago he had his arms emerged into a sprayer tank with the diluted Gly-41 product to unclog the sprayer. He did wash up immediately after the exposure but he began to have diarrhea soon after the exposure and he is still having it (symptoms persisting one month).
020092 - 00001	8/1/2008	MO	000524-00445	ROUNDUP HERBICIDE	103601	MODERATE	Woman calling that was spraying unknown formulation of Roundup Herbicide Concentrate when the sprayer cap came off and sprayed her in the face and eyes. She took a shower and rinsed her eyes for about 30 minutes as they were stinging and burning. She is still having a burning sensation and hazy vision at the time of the call. The eye is not tearing. The next morning, the woman states she had rinsed her eye with well water for approximately one hour last evening just to be sure it was adequately rinsed. This morning she notes a foreign body sensation. The woman states she also got some of the product in her mouth yesterday which resulted in a bitter taste that has now gone away. On follow up, the woman states her MD discovered a small scratch on her cornea

Incident Package Report	Incident Date	Location	Reg Number	Product Name	PC Code	Exposure Severity	Incident Description
							and was given eye medications.
020111 - 00245	8/1/2008	MI	071995-00027-000239	BASIC SOLUTIONS WEED AND GRASS KILLER	103601	MODERATE	A 48 year old female reports that her landlord applied product in yard 3 wks ago. Caller walked barefoot in the yard 2. 5 wks after the product had been applied. That night, caller felt exhausted, developed a migraine headache, itchy eyes, palms and feet were red and itchy (BSA 6%). She developed hives and bleeding with development of scabs on her eyelids. She continued to have insomnia for the past 4 nights. Caller's symptoms have nearly subsided by scrubbing her skin daily with soap and water. She did not seek medical treatment by a physician.
020180 - 00018	4/25/2008	GARDEN GROVE, CA	000524-00445	ROUNDUP READY-TO-USE HERBICIDE (UNSPECIFIED)	103601	MAJOR	A fifty-five (55) year old male allegedly deliberately ingested approximately I 00 milliliters of "Roundup Ready To Use" herbicide, and an unknown amount of acetaminophen with the intent to commit suicide.
020180 - 00023	5/16/2008	FONTANA, CA	000524-00445	ROUNDUP	103601	MODERATE	A twenty-three (23) year old male allegedly was exposed to a "Roundup" product when a sudden gust of wind blew the pesticide onto him, causing skin exposure and inhalation. He was applying it to residential landscape plants on a property in Fontana as part of his father's company's maintenance gardener service. He soon experienced symptoms of dizziness, shivering, weakness, flushing, diarrhea, and later became feverish. The victim drove himself to Pomona Valley Medical Center that evening since it was closer to his home and he was admitted overnight.
020222 - 00001	8/1/2008	IA	000524-00536	ROUNDUP POWERMAX	103601	MODERATE	Caller states, about a month ago he was wearing rubber gloves when he had gotten Roundup Powermax Concentrate poured inside of the glove. The caller states that the concentrate sat in contact with his skin for 2-3 minutes. He did wash the skin off very well at that time. Over the past three weeks, the caller has developed arthritis-like symptoms of his hands.
020223 - 00001	7/1/2008	GA	000524-00445	ROUNDUP HERBICIDE	103601	MODERATE	A 78 year old female sprayed a lot of Roundup Herbicide, unknown dilution or whether or not it was a ready to use product. She may have inhaled a

Incident Package Report	Incident Date	Location	Reg Number	Product Name	PC Code	Exposure Severity	Incident Description
							lot of it. The woman had a sore throat around the time of using the product and now has a chronic cough.
020322 - 00001	10/1/2008	IN	071995-00032	ROUNDUP WEED & GRASS KILLER READY-TO-USE	103601	MODERATE	Caller states an eight year old child got some Roundup Ready to Use spritzed into his right eye. They have rinsed his eye for about five minutes. The caller is asking if they should they go to the ED. On follow up, the child had been taken to the ED and was diagnosed with a small corneal abrasion per fluorescein stain. The evaluating physician stated the abrasion was not related to the Roundup.
020324 - 00001	9/1/2008	MO	000524-00445	ROUNDUP HERBICIDE	103601	MODERATE	A caller sprayed her rose bushes for bugs with malathion. She thinks maybe the wind blew some of the spray back onto her skin. Two weeks later, she went to her PMD with the symptom of a rash on her chin. She has returned to her physician three times and has taken three different pills for her symptoms. She called the malathion people, who thought maybe the symptoms may have been caused by Roundup and was given this number to inquire. The caller had used a sprayer that at some time in the past might have held a Roundup product and then had been rinsed prior to use with malathion. She doesn't really think her symptoms are related to the Roundup. The rash had gone away, but at the time of the call on 1 0/15/08 the symptoms have reappeared.
020326 - 00001	8/1/2008	CA	000524-00445	ROUNDUP HERBICIDE	103601	MODERATE	Caller states approximately 2 months ago he was using a backpack sprayer at work with an unknown formulation of Roundup Herbicide. It leaked all over his back. He didn't notice that it had leaked and kept working all day long using the backpack sprayer. He did not wash until that evening. He used the backpack sprayer on two more occasions. That day his skin became very hot, a rash developed which comes and goes and itches. Sometimes, his body is numb.
020546 - 00001	8/1/2008	MO	000524-00445	ROUNDUP HERBICIDE	103601	MODERATE	Caller's son complained to her last month that he had been feeling ill for some time. Son mentioned that he sprayed some Roundup on plants in his

Incident Package Report	Incident Date	Location	Reg Number	Product Name	PC Code	Exposure Severity	Incident Description
							backyard 4 months ago. Caller does not know the type of Roundup that was sprayed or the type of exposure that her son had. Son complained of blurred vision and gastrointestinal problems, sleeping a lot, urinating a lot and blood in stools. He saw a PMD to have medical tests for diabetes which was negative.
020550 - 00001	1/1/2009	FL	000524-00445	ROUNDUP HERBICIDE	103601	MODERATE	Wife calls to say her husband used Roundup to kill weeds and Triazicide to kill ants about 15 minutes ago. He came inside to eat dinner and approximately 5 to 7 minutes later he had symptoms of his peripheral vision becoming dark; telling his wife he could not see. The wife has rinsed his eye and is wondering if either product caused his symptoms. He may have gotten symptoms from the mist of the product but he has no recollection of the product in his eyes. No direct spray to the eye.
020586 - 00001	1/1/2009	FL	071995-00032	ROUNDUP WEED & GRASS KILLER READY-TO-USE	103601	MODERATE	An adult male used the Roundup product about 3 to 4 weeks ago. He got it on his hands and has been battling a rash and cracking of skin on the hands. He has been using a product called Lac Hydril cream on his hands without much help. He saw his physician 2 days ago and was prescribed clobetasol cream. On follow up, 4 days later, the rash was improving but seemed to worsen at times. The man had been using Vaseline on his hands along with the clobetasol cream and wearing rubber gloves which seemed to make his symptoms worse. On subsequent follow up, a female family member reports that the man's hands continue to improve greatly. The rash is almost gone. He has been using the clobetasol cream and keeping his hands open to air.
020588 - 00001	5/1/2008	LA	000524-00445	ROUNDUP HERBICIDE	103601	MODERATE	An adult male was exposed numerous times spraying fence lines last spring and summer. The man is a part-time farmer and was using a backpack sprayer. The man states he planted corn and then after planting went through the field and fence line with Roundup ready corn. Caller states he has also used a termite control product. The man

Incident Package Report	Incident Date	Location	Reg Number	Product Name	PC Code	Exposure Severity	Incident Description
							has been to 8 different physicians to resolve a skin issue. The man states the rash has involved his entire body. The rash moves around, one day it is on his torso and then 2 weeks later it goes to another area. He states his skin welts after scratching. He states he has had constant pain, itching and burning for the past 8 to 10 months. The caller has taken many medications and used topical products with no help.
020638 - 00001	3/1/2009	CA	000524-00343	AQUAMASTER	103601	MODERATE	Caller was riding his bike up and down a hill. The parks service was spraying Aqua Master on the side of the road with a tractor to the right of him. He felt a mist on his face, which tingled a bit. He also thought maybe his face felt numb temporarily. This has subsided. He also got a terrible taste in his mouth. The taste persists despite this happening about 3 hours ago. About 20 minutes after the exposure, he noticed, tremors in his right hand, which have subsided.
020639 - 00001	3/1/2009	TX	071995-00025	ROUNDUP WEED & GRASS KILLER SUPER CONCENTRATE	103601	MODERATE	Caller used Roundup about 5.5 hours prior to calling. She first used a brush to apply before diluting and got some on her hands. She then used the sprayer and got some more on her hands. She did wash off after using the product. The caller also took a vicodin for shoulder pain, which she has taken before, at about the same time as the use of the Roundup. Woman is calling now because she felt faint earlier. She now has vision changes and is jittery. No dermal symptoms.
020725 - 00031	12/2/2008	CA		HONCHO	103601	MODERATE	A 47 (forty-seven) year old male, was exposed to a herbicide and an insecticide (U.S. EPA registration numbers unknown) while he was applying them. He experienced weakness, dizziness, and trouble swallowing and was admitted to the hospital. He was later released two days later. He had been applying and handling pesticides for the last four years without proper pesticide training. In addition, he was not provided with the correct and/or appropriate personal protective equipment at the time of the pesticide exposure.
020770 -	3/25/2009	LAKEPORT, CA	071995-	ROUNDUP WEED	103601	MODERATE	An adult female had post application exposure to

Incident Package Report	Incident Date	Location	Reg Number	Product Name	PC Code	Exposure Severity	Incident Description
00001			00025	& GRASS KILLER SUPER CONCENTRATE			the product (applied by gardeners). She experienced rash, cough and brown spots on her skin. She was in bed for three days detoxing with pectin and sulfur glutathione nasal wash.
020795 - 00001	4/1/2009	NC	071995-00023	ROUNDUP WEED & GRASS KILLER1 READY-TO-USE	103601	MODERATE	An adult male mixed product with water and used a pressurized sprayer that malfunctioned, sprayed him in the face, and got the product in his eyes. He then splashed water into his eyes. Several hours later he was still having redness, slight periorbital edema, and discomfort to the eye. He didn't irrigate more than a of couple minutes. He had irrigated his eyes but for a short amount of time but 3.5 hours later he was still complaining of irritation, tearing and some crusting of drainage. The ED MD just looked at his eye visually, no instruments were used. The MD said there was a burn and an infection in both eyes. Antibiotic drops were prescribed.
020796 - 00001	4/13/2009	NV	071995-00032	ROUNDUP WEED & GRASS KILLER READY-TO-USE	103601	MODERATE	Caller states he used Roundup Ready to Use about 30 minutes ago, when the wind blew some mist back into his face and he accidently inhaled some. Caller states he is having nausea, difficulty breathing, feels short of breath, no vomiting. Caller states he does have a history of COPD. On follow up, the man states he is still having difficulty breathing and stated he had a seizure. Man states he has a history of a seizure disorder. On follow up with the ED after several unsuccessful attempts earlier, the RN states the man had a low dilantin level. He did not have any respiratory symptoms and did not require any breathing treatments. The RN states the man is in the ED frequently and was discharged to home several hours ago.
020800 - 00001	4/5/2009	VA	000524-00445	ROUNDUP HERBICIDE	103601	MODERATE	A 30 year old adult male suicide attempt (ingested approximately 3oz).
020802 - 00001	4/16/2009	CA	000524-00445	ROUNDUP HERBICIDE	103601	MODERATE	Caller states he used Roundup Concentrate extensively on his property about 2 weeks ago. He mixed it according to the package directions. The man states it had sprinkled rain at least once since he had applied the Roundup. Yesterday, he was digging fence posts in a gravel-like bed where he

Incident Package Report	Incident Date	Location	Reg Number	Product Name	PC Code	Exposure Severity	Incident Description
							had previously sprayed the Roundup. It was very windy. The man was wearing boots, gloves, long sleeved shirt and long pants. He noticed his hands were itching and he went in and washed his hands. He states his feet began itching and then he went into 'shock.' The man's wife called an ambulance and he was taken to an ED. He was treated with Benadryl and other "anti allergy stuff' and given intravenous fluids. The man states the physician could find no reason for his symptoms. No bite or sting was noted. The man was discharged to home and now is asymptomatic.
020803 - 00001	4/16/2009	OR	000524-00445	ROUNDUP HERBICIDE	103601	MODERATE	Caller states she is a first responder from Oregon state calling about herself and her neighbor. Today, the street was sprayed with a combination of 3 herbicides, Glyphosate (Buccaneer), Milestone from Dow chemical and Spyder which contains 'Sulfometuron methyl (applied from a helicopter). She is also concerned about her neighbor that takes Cyclobenzaprine, asking if the chemicals could be interacting with his medication. The caller states she has also been exposed to the same chemicals since she lives on the same street. She has a history of liver disease. The neighbor refuses to go MD or the hospital. The neighbor has a severe headache 'left sided in occipital area with 'brain swelling', 'mastoid swelling neck', and muscle spasms. Onset of symptoms was 2-3 days ago, sometimes he tells her 2-3 weeks ago. The caller states she has had muscle tremors, hot and cold flashes, chills, occipital headache, mastoid swelling, and headache since last week. She states her heart was irregular a couple of days ago.
020813 - 00177	4/17/2009	LITTLE SILVER, NJ	071995-00008-000239	TOTAL KILL WEED & GRASS KILLER READY-TO-USE	103601	MODERATE	A 4 year old male sprayed the product. It was unclear if the child had any exposure to the product. The next day, the child woke up with swollen eyes. He went to MD and was prescribed a steroidal ointment. Two days later he was greatly improved.
020875 - 00002	5/1/2009	NC	071995-00032	ROUNDUP WEED & GRASS KILLER	103601	MODERATE	Caller states 8 year old walked in front of a spray of Roundup Ready to Use Weed and Grass Killer

Incident Package Report	Incident Date	Location	Reg Number	Product Name	PC Code	Exposure Severity	Incident Description
				READY-TO-USE			2% about 24 hours ago. He was instructed to go inside and wash it off but evidently did not because he developed rash and itching later. Mother called back several hours later to report that the child developed hives on his legs, abdomen, back and upper arms. He was also started on a new medication last week which he stopped due to a stomach virus but restarted today. The child was evaluated by his pediatrician who administered an antihistamine injection. The MD thought the symptoms may be related to a post viral reaction. Child to follow up with his pediatrician.
020875 - 00003	5/1/2009	NJ	071995-00032	ROUNDUP WEED & GRASS KILLER READY-TO-USE	103601	MODERATE	Caller states that she was using Roundup Ready to Use yesterday and got some of the foam on the back of her hand. She did not think much about it and just wiped off the Roundup instead of washing it off. She reports within a few hours of the exposure, she began to feel tremendously dizzy. She is able to monitor her blood pressure and it was 225/101 mmhg.
020875 - 00005	5/1/2009	MO	000524-00445	ROUNDUP HERBICIDE	103601	MODERATE	Ophthalmologist calling about a woman that got an unknown formulation of a Roundup concentrate in her eye yesterday. Unknown if immediate first aid provided or not. The eye was diagnosed as having an acid burn with minor corneal staining. Artificial tears recommended. The woman was discharged to home.
020875 - 00006	5/1/2009	NY	000524-00445	ROUNDUP HERBICIDE	103601	MODERATE	Son calling from the ED with his father being evaluated for sudden onset of short term memory loss and sharp pain in his head. He sprayed Roundup this morning and then at 4 pm, he was talking with a neighbor and all of a sudden didn't remember anything and had a sharp pain in his head. He sprayed the product normally, with no significant exposure. They are currently in an ED, waiting for the MD to evaluate him.
020988 - 00001	7/12/2009	KS	004787-00023	GLYFOS X-TRA HERBICIDE	103601	MODERATE	Caller's husband had been spraying diluted Glyfos X-TRA Herbicide and started to develop flu-like symptoms, fever and chills the next day. Patient sought medical care and was prescribed

Incident Package Report	Incident Date	Location	Reg Number	Product Name	PC Code	Exposure Severity	Incident Description
							azithromycin and propoxyphene. According to patient, the medications were not working.
020997 - 00031	6/6/2009	AR	000239-02637	GROUNDCLEAR VEGETATION KILLER CONCENTRATE	103601	MODERATE	A 55 year old male sprayed the diluted product along the driveway and fence. He was wearing shorts. Two days later he developed knee to ankle petechia rash with edema and cellulitis developing. CNP thinks it is a combination product and sun exposure. He was given Prednisone and 2 Decadron injections. He went back to MD because he developed fever/chills/rash/bumps that are now itchy and raised. He was treated with Benadryl and an inhaler for a previous condition. He was also prescribed lincocin.
021052 - 00001	6/1/2009	MO	000524-00445	ROUNDUP HERBICIDE	103601	MODERATE	Caller states, a few days ago, she became very lethargic and felt like she couldn't get enough oxygen. Her cat also had been sick recently. The caller states she had gone to run an errand and noticed some blue stuff on the ground near where she lives. She called the state department and was told that the product was Roundup.
021060 - 00001	6/1/2009	MS	071995-00017	ROUNDUP CONCENTRATE WEED & GRASS KILLER 1	103601	MODERATE	Caller states he sprayed over 1 gallon of Roundup. It is questionable whether his shirt was damp from the overspray. Caller states it was hot outside. He states there was some overspray on his feet. While spraying, caller states he had a burning spot on his neck which stopped burning when he washed it off. He took a shower 3-4 hours after application. The next day, he woke up itching, a rash on his hands, arms and feet (not like poison ivy) and welts all over him. He had a boiled lobster look. He took Benadryl 25 mg which resolved the symptoms.
021064 - 00001	6/28/2009	OH	000524-00445	ROUNDUP HERBICIDE	103601	MODERATE	Caller states her 36 year old son had a seizure at church on Sunday 6-28-09. The day before, on Saturday, he sprayed Roundup using a backpack sprayer. It was a windy day. Unknown if any mist blew onto his skin.
021065 - 00001	1/1/2009	FL	000524-00445	ROUNDUP HERBICIDE	103601	MODERATE	Caller states, for the past year he has had atypical seizure disorder. He is wondering if it could be caused by his exposure to Roundup Weed and Grass Killer. He typically used a 41% glyphosate formulation and diluted it according to directions.

Incident Package Report	Incident Date	Location	Reg Number	Product Name	PC Code	Exposure Severity	Incident Description
							He doesn't recall a specific exposure to the chemical. He states he is just trying to rule out causes for his seizures.
021191 - 00021	8/4/2009	IL	000239-02637	GROUNDCLEAR TRIOX TOTAL VEGETATION KILLER 1	103601	MODERATE	An adult male used the product. While he was spraying the hose on his sprayer broke and it sprayed all over his skin. He stated he did wash initially, but now has an infection in his mouth. He has seen a dentist and is being treated. The dentist is not sure of cause of infection.
021244 - 00001	6/1/2009	OH	000524-00445	ROUNDUP HERBICIDE	103601	MODERATE	Caller used a Roundup Weed and Grass Killer Pull and Spray product at least 2 months ago. He was spraying around plants. He thought he was sweating, but apparently the sprayer was leaking onto his hand. He did not realize this until after he was done spraying. Since then, he has gotten huge blisters on his hands. He says they are as large as a thumb. He says they're so deep that you can see the muscle. He has been to the doctor and the doctor gave him 2 pills to take, but the pills didn't help. The doctor didn't tell him what was wrong with his hands.
021245 - 00001	8/1/2009	MA	000524-00445	ROUNDUP HERBICIDE	103601	MODERATE	Caller reports, a neighbor sprayed Roundup unknown concentration diluted 3 ounces to 1 gallon of water, on poison ivy outside the front of her home, approximately 5 yards away. Her windows were open. Within an hour she reports becoming dizzy, experienced a headache unrelieved by ibuprofen, a little relief with aspirin, nausea, shakiness and trembling. Symptoms are better if she lies flat. "Something wrong with her head and spinal cord". She was finally better and then her neighbor sprayed again 6 days later, and the symptoms have started all over again. She feels fine when she is lying down but the symptoms return when she gets up. She denies mishaps or any direct contact with the product.
021247 - 00001	8/1/2009	NC	071995-00032	ROUNDUP WEED AND GRASS KILLER READY TO USE	103601	MODERATE	Caller states that she had been spraying Roundup Ready to Use yesterday and had left the bottle sit on the front porch. At some point, she found her 2 year old grandson with the bottle and he had been spraying the Roundup. He was spitting out acting

Incident Package Report	Incident Date	Location	Reg Number	Product Name	PC Code	Exposure Severity	Incident Description
							like there was a bad taste in his mouth at that time. Caller was not concerned at the time but the child woke up with symptom of shaking badly last night at 0300. He is currently sleeping now and has an appointment with his PMD this afternoon.
021250 - 00001	8/1/2009	DE	071995-00023	ROUNDUP WEED & GRASS KILLER 1 READY TO USE	103601	MAJOR	Caller states his 88 year old mother is in the hospital with kidney problems. The son is calling to see if Roundup could be a factor in her illness. He states that in the last 6 months, his mom has used 4 containers of the Roundup Weed and Grass Killer Ready to Use. No actual ingestion, nor dermal exposure. The son is concerned that she may have inhaled some.
021251 - 00001	8/1/2009	MS	000524-00445	ROUNDUP HERBICIDE	103601	MODERATE	Caller states sometime yesterday, his 5 year old son must have gotten near some Roundup. No further history of any actual exposure available. Child may also have gotten some trash and dirt in his eye this morning while playing outside. This morning, the child's eye was swollen and painful so he couldn't open it. Dad took to him to the emergency department and they diagnosed a big scratch on one eye and prescribed hydrocortisone drops. Now this evening, the child's other eye is painful and swollen. Dad has given an over the counter analgesic and put the child to bed.
021252 - 00001	8/1/2009	SC	000524-00445	ROUNDUP HERBICIDE	103601	MODERATE	Caller states her spouse was sick with a high fever, dehydration and confusion last week. He is better now. He had good care by the doctor. She states he uses Roundup a lot but is unaware of any specific exposure.
021254 - 00001	7/1/2009	VA	071995-00008	ROUNDUP READY TO USE WEED AND GRASS KILLER	103601	MODERATE	Caller used Roundup in high weeds for 2 days. About two weeks later, he developed a bumpy, itchy rash all over his legs and arms. Approximately a month later, the rash is on his back. No mishaps with the product. He does not recall becoming wet with the product. He has seen a dermatologist for treatment and has had biopsies done. He has been taken off all his medications except his antihypertensive.
021256 - 00001	7/1/2009	OH	000524-00445	ROUNDUP HERBICIDE	103601	MODERATE	Caller believes her neighbor upstairs is using Roundup and Miracle Gro. She states she was

Incident Package Report	Incident Date	Location	Reg Number	Product Name	PC Code	Exposure Severity	Incident Description
							outside while the neighbor was spraying the other day but denies dermal contact. She is suffering from hoarseness, dizziness, light headedness and skin burning sensation.
021397 - 00001	9/1/2009	CA	071995-00023	ROUNDUP WEED AND GRASS KILLER 1 READY TO USE	103601	MODERATE	Spouse got Roundup Weed and Grass Killer Ready to Use on his skin. He had on shorts and flip flops. He denies mishaps or spills but was walking thru the weeded area he had treated. No recall of being wet with the product. He suspects he showered the next day. A few days later, he developed a biting sensation on his ankles and feet. At first, he attributed the symptom to insect bites, and started wearing soaks and used mosquito spray. The symptoms worsened and he developed tiny bumps and tiny fluid filled blisters that looked like herpes on the back of his hands. The symptoms then progressed to the dorsum of feet. About 6-7 weeks later, the rash is generalized all over his arms, legs, trunk, buttocks and hands with itchy, weeping blisters and bumps. He saw a dermatologist, who was not sure what it was. The caller mentioned Roundup and she told him that was likely the cause. He has a prescription for a steroid dose pack but had not used it. He is using topical steroids.
021398 - 00001	9/1/2009	WA	071995-00025	ROUNDUP WEED & GRASS KILLER SUPER CONCENTRATE	103601	MAJOR	Call from an emergency crew on scene where an 84 year old male drank Roundup Weed and Grass Killer Super Concentrate approximately 20 minutes prior. His wife found him in the garage when he told her he had intentionally drunk from the 35 ounce container which is now almost one third gone. They estimate 6 ounces ingested;
021401 - 00001	10/1/2009	TN	071995-00032	ROUNDUP WEED AND GRASS KILLER READY TO USE	103601	MODERATE	Caller states that a month or so ago, he was turning the selector nozzle on Roundup Ready to Use when a small amount of the foam got on the corner of his eye. The eyelid, only, was exposed. He remembered thinking that he should wash that off when he was done but he may or may not have rinsed it. About a day later, he began to have a minor itch at the exposed site and peeling skin

Incident Package Report	Incident Date	Location	Reg Number	Product Name	PC Code	Exposure Severity	Incident Description
							from that area. Both symptoms persist to today. He has applied hydrocortisone cream to the area maybe once or twice.
021466 - 00001	11/1/2009	ND	000524-00445	ROUNDUP HERBICIDE	103601	MODERATE	Caller stated he used a concentrate Roundup Weed Killer for farming, trying to kill trees. He is unsure how it was diluted. He had a typical overspray exposure, and showered at the end of the day. Two days later, he got out of bed and fell. He was seen in the emergency department and was diagnosed as having Guillain-Barre. He went to the Mayo Clinic, 2 months ago, and was told his symptoms are consistent with Guillain-Barre. He is still having muscle weakness in his legs.
021610 - 00001	1/23/2010	HI	000524-00475	ROUNDUP PRO	103601	DEATH	49 yr. old Hawaiian man intentionally ingested Roundup Pro, death. ER staff said there was nothing they could do
021635 - 00001	9/1/2009	NJ	071995-00025	ROUNDUP WEED & GRASS KILLER SUPER CONCENTRATE	103601	MODERATE	Caller states about 4 months ago some diluted Roundup Weed and Grass Killer Super Concentrate splashed on his leg when he was applying the product. He did not wash it off until later when he started having burning and stinging on his legs. He has been to two different dermatologists and his PMD over the past 4 months and has been given three different creams that have not gotten rid of the burning sensation. The symptom is still present off and on.
021635 - 00002	11/1/2009	FL	000524-00445	ROUNDUP HERBICIDE	103601	MODERATE	Caller states she sprayed weeds with an unknown type of Roundup less than 2 months ago. She used one glove for pulling weeds that were sprayed with the Roundup and then folded her arms while talking to neighbors. She developed a rash on the upper arm area several days later and the rash has remained since then. She is under the care of a dermatologist who cannot say what the cause is. The area is red now. It started as a mosquito bite like nodule, hard boil, and dime size bumps under her skin. She never had any blistery rash.
021817 - 00001	3/23/2010	CA	000524-00445	ROUNDUP HERBICIDE FROM MONSANTO	103601	MODERATE	Caller states that about one month ago, her gardener applied an unknown formulation of Roundup from a golf course to her weeds outside. Her small dog was outside running in that area the

Incident Package Report	Incident Date	Location	Reg Number	Product Name	PC Code	Exposure Severity	Incident Description
							next day and developed small pinpoint lesions on its face which seemed to bother the dog by itching. After holding the dog, she too has developed pinpoint bumps with craters in them, which are extremely pruritic on her arms. She has seen a dermatologist and they have done biopsies which are pending.
021819 - 00001	3/6/2009	OH	000524-00445	ROUNDUP HERBICIDE	103601	MODERATE	Caller states, in the spring a year ago, she was using a Roundup product at work. Some went onto her pant leg and into her sock. Some went onto her ankle which she wiped off with a wet paper towel and soap soon afterwards. Since then she has had an intermittent rash on her ankle that gets dark when she scratches it. She has consulted her PMD.
021898 - 00001	4/9/2010	OH	000524-00445	ROUNDUP HERBICIDE	103601	MODERATE	Caller used a Roundup product 2 weeks ago. She got some into her eye and it burned, so she flushed it for 1-2 minutes with water. Seven days ago, she noticed large floaters in her eye. She contacted her PMD, who told her to see an eye doctor immediately, but she didn't. Today, she has thousands of black spots that she sees. Caller states symptom came on suddenly. Eyes feel dry and hurt.
021899 - 00001	3/26/2010	OH	000524-00445	ROUNDUP HERBICIDE	103601	MODERATE	Caller states she used Roundup more than 1 month ago. She vaguely remembers a drip getting onto her hand or wrist area. She doesn't think she washed it off right away because it was such a minimal amount. For several weeks, she has had an area on the top of her wrist that is a patch of bumps that resembles poison ivy and weeps a yellowy discharge. It itches and appears to be gradually getter larger. It started out looking like 4-5 bug bites, but it has progressively gotten worse. She is going to MD next week.
021900 - 00001	4/15/2010	CO	071995-00023	ROUNDUP WEED AND GRASS KILLER 1 READY TO USE	103601	MODERATE	Ophthalmologist is seeing a 39 year old male with a complaint of pupil dilation in one eye only. In trying to determine the cause, the man reports using Roundup Weed and Grass Killer Ready to Use, four days ago. He is not aware of getting any in his eyes, but states it might have blown there.

Incident Package Report	Incident Date	Location	Reg Number	Product Name	PC Code	Exposure Severity	Incident Description
							No complaint of eye irritation or redness at the time of use.
021902 - 00001	3/24/2010	OH	000524-00445	ROUNDUP HERBICIDE	103601	MODERATE	Caller notes that several weeks ago she was using Roundup concentrate (6 ounces to 1 gallon) dilution and then also mixed it (12 oz to 1 gallon). Some was sprayed on her hands and legs when her sprayer got clogged. She has been noticing muscle spasms to her hands, feet, and legs and urinary incontinence.
021983 - 00001	5/15/2010	MO	042750-00061-072693	CROP SURE GLYPHOSATE PLUS	103601	MODERATE	An adult male indicates he was exposed to the product 2 weeks ago. He was sitting on an ATV seat saturated with diluted product. He reports he developed a severe rash all over my body. He saw a doctor and was placed on the oral antibiotic doxycycline. The caller also reports he had developed diarrhea for three days following the dermal exposure described. The caller is ASX at this point.
021983 - 00002	5/24/2010	IL	042750-00061-072693	CROP SMART GLYPHOSATE 41 PLUS	103601	MODERATE	An adult male states that product spilled on his leg one week ago. Two days ago his wife noticed some swelling in his lower legs.
021990 - 00001	5/9/2010	AZ	071995-00023	ROUNDUP WEED AND GRASS KILLER 1 READY-TO-USE	103601	MODERATE	Caller states that he got Roundup Ready to Use (unknown formulation) on him this past January (approximately 4 months ago). It sprayed on him when he opened the container. Caller states he has had symptoms of numbness and swelling of tongue and lack of taste since the exposure.
021991 - 00001	5/14/2010	TX	000524-00454	HONCHO PLUS HERBICIDE	103601	MODERATE	Man works at a tractor supply store and has become sensitive to some chemicals he works with at the job. Last evening, he was mixing Honcho Plus around 6-6:30 pm, getting the concentrate on his hands while mixing. He did rinse with water promptly and later with soap and water. He did feel burning on his hands at the point of contact but no rash or redness noted after rinsing with water. Around 10 pm when his spouse saw him at home, he was disoriented and confused, she brought him to the local ER.
021992 - 00001	5/11/2010	MO	071995-00017	ROUNDUP CONCENTRATE WEED AND	103601	MODERATE	Man sprayed Roundup on his property today. No known exposure. Tonight he is having significant symptoms but refuses to be checked out at the ED.

Incident Package Report	Incident Date	Location	Reg Number	Product Name	PC Code	Exposure Severity	Incident Description
				GRASS KILLER 1			He has symptoms of dizziness, walking into walls, drowsiness, and ataxia.
021993 - 00001	5/5/2010	OH	071995-00023	ROUNDUP WEED AND GRASS KILLER 1 READY-TO-USE	103601	MODERATE	Caller used a Roundup Ready to Use product, 2 days ago in her yard. No mishaps during use. Yesterday, she was working in her yard in the area she had sprayed the day prior and noticed her hand was itching. Then the back of her neck, and legs broke out. She has generalized hives, swelling and itching. She is concerned she came in contact with the Roundup and worried that it is causing her symptoms.
021994 - 00001	5/28/2010	MO	071995-00023	ROUNDUP WEED AND GRASS KILLER 1 READY-TO-USE	103601	MODERATE	Woman used Roundup Weed and Grass Killer Ready to Use 2 days ago, getting some on her hands and spilling some on her feet while pouring it from one container to another. The smell of the product makes her feel lightheaded. She did wash well but did not feel well later in the day, becoming nauseated and continued to be nauseated. She was at the dentist office yesterday. She had her BP checked at 83/58. Today, her fingertips are numb. She denies history of medical problems. She did not ingest any Roundup.
022100 - 00001	6/19/2010	HI	000524-00445	ROUNDUP HERBICIDE	103601	MODERATE	Call from Hawaii at a hardware store where 2 days ago, a weed killer that was in a sprayer device was returned to the store. It was evidently sprayed on the arm of an employee at that time. She did not get to wash it off right away but rinsed a few minutes later. She states the customer told her it contained Roundup, but there was no way to verify what was in the container. The employee complains of a red, flushed look to her arm and leg (leg was not sprayed). She feels a funny tingling type sensation to the skin, and complains of chest pain and shortness of breath.
022101 - 00001	6/18/2010	OH	071995-00032	ROUNDUP WEED AND GRASS KILLER - READY TO USE	103601	MODERATE	Caller states, 2 days ago her friend sprayed Roundup Ready to Use on some very tall weeds. The day after spraying, she started to have trouble breathing and can hardly walk now, without becoming winded. The friend thinks that she may have breathed in some of the mist while spraying the Roundup.

Incident Package Report	Incident Date	Location	Reg Number	Product Name	PC Code	Exposure Severity	Incident Description
022102 - 00001	6/30/2010	NY	000524-00445	ROUNDUP HERBICIDE	103601	MAJOR	Call coming from Syracuse EMS and they are en route to a home where an adult male is unconscious and has been reportedly using Roundup all day. No other details are known, caller wants to know what type of herbicide is in the Roundup and if it would cause this type of symptom.
022103 - 00001	6/24/2010	MO	000524-00454	BUCCANEER PLUS HERBICIDE	103601	MODERATE	Caller states she was spraying with Buccaneer Plus about May 25th in her yard. It was diluted to label directions. She sprayed for about 3 hours then came in and took a shower. The day before she knew she had been around poison ivy and started itching. MD prescribed her Prednisone. Since then, she has seen MD about 4 times. She says her skin is swollen from head to toe for one week. Her skin appeared to be turning orange from a burn, the past 4 days, with some skin peeling. MD asked her if she was exposed to herbicides and is treating her now with Bactrim to 'get poison out of her '.On follow up the nurse practitioner stated she did not feel the woman's symptoms were related to the Buccaneer Plus.
022175 - 00002	7/8/2010	ALTOONA, PA	053883-00059	SURRENDER ERASER SYSTEMIC WEED & GRASS KILLER	103601	MODERATE	A 17 year old male sprayed this product outdoors using a backpack sprayer for about 3 hrs. He was not wearing any PPE, just shorts and a t-shirt. Some of the product spilled down the back of his shirt. He showered that night as usual, but woke up the following morning with 'flu-like symptoms' as well as some muscle and joint pain. No fever or other symptoms. Although he was "80% better," three days later he saw his MD. No specific treatment was rendered at that time as he was getting better on his own.
022192 - 00002	7/28/2010		000524-00445	ROUNDUP HERBICIDE	103601	MODERATE	Caller states her husband was spraying Roundup concentrate. The wind was blowing while spraying. She found her husband lying on the grass. She got him inside and he took a shower. His nose is congested.
022192 - 00003	7/17/2010	MO	071995-00018	ROUNDUP WEED AND GRASS KILLER 1-SUPER CONCENTRATE	103601	MODERATE	Woman presents to the ER with a complaint of numbness to both legs and difficulty urinating. She is able to go only small amounts since Wednesday. The RN believes, on Wednesday, the woman was

Incident Package Report	Incident Date	Location	Reg Number	Product Name	PC Code	Exposure Severity	Incident Description
							using Roundup concentrate that she had diluted and got some on her feet. There are few details of the exposure. The woman denies using any other chemicals.
022192 - 00005	7/20/2010	CT	071995-00023	ROUNDUP READY TO USE POISON IVY AND TOUGH BRUSH KILLER 3	103601	MODERATE	Caller states he spilled some Roundup Ready to Use Poison Ivy and Tough Brush Killer 3 on his thumb about 30 minutes ago. At the time of exposure, he used hand sanitizer to rub it off. About 10 minutes later, he washed with water and soap for 5-10 minutes. He notes some redness on his skin just below his wrist but not on his thumb at the point of contact. He states he feels tingling of the hand and is dizzy. On follow up, the man stated he was at the emergency room because he was short of breath and felt like he was going to pass out from being dizzy. He states his tongue went white and his mouth was dry.
022192 - 00007	7/1/2010	LA	000524-00445	ROUNDUP HERBICIDE	103601	MODERATE	Caller and her sister are elderly. They have an absentee landlord neighbor whose lot adjoins theirs. In the middle part of April, he sprayed the grass between their homes. They began having symptoms at that time. Symptoms experienced were, sore throat with "pus sacs" and red pimples down the throat, burning sensation in the skin and coming up out of the esophagus, abdominal cramping, vomiting, itching, hair loss and headaches. Their MD gave them a Z pack antibiotic, and eventually they were doing all right. On the 24th of May they saw the neighbor out spraying and then leaving. They felt stinging of their eyes and skin, respiratory irritation, dizziness at the time of spraying. They got another Z pack antibiotic from PMD afterwards.
022193 - 00002	1/1/2010	KAUNAKAKAI, MOLOKAI, HI		ROUNDUP	103601	C,MODERATE	Roundup sprayed near female AA member: malaise, sinus discharge, Part vague: mentions death nearby after Roundup was used
022193 - 00003	11/1/2009	MOLOKAI, HI		ROUNDUP	103601	DEATH	Roundup sprayed near female AA member: malaise, sinus discharge, Part vague: mentions death nearby after Roundup was used
022268 - 00001	8/30/2010	VA	000524-00445	ROUNDUP HERBICIDE	103601	MAJOR	Caller states her sister-in -law drank a pint of Roundup - unknown formulation yesterday. The

Incident Package Report	Incident Date	Location	Reg Number	Product Name	PC Code	Exposure Severity	Incident Description
							woman was out on pass from a psychiatric center and when she returned she was vomiting.
022270 - 00001	8/2/2010	IL	071995-00032	ROUNDUP WEED AND GRASS KILLER-READY TO USE	103601	MODERATE	Woman spraying the Roundup Ready to Use this afternoon and thinks that she got some on her hand and then rubbed it into her eye. Tonight, her eye is very irritated and is lachrymating. Woman has removed her contact lens. On follow up the next morning, the woman went to her eye doctor early in the morning and was diagnosed with severe chemical burn to the cornea. The doctor prescribed antibiotics. It was noted that at the time of the exposure, the caller had no burning sensation or irritation.
022271 - 00001	8/31/2010	VA	071995-00032	ROUNDUP WEED AND GRASS KILLER-READY TO USE	103601	MODERATE	Caller states that his father was using Roundup Ready to Use yesterday and got some of the spray in his hair. He did shampoo his hair soon after the exposure. At some point he was reading a newspaper and has a habit of licking his finger to help turn the page. When he licked his finger he noted immediately the left side of his tongue went very numb. He woke up this morning with left sided facial drooping and his left eyelid is drooping.
022272 - 00014	7/22/2010	DE	071995-00008-000239	TOTAL KILL WEED & GRASS KILLER READY-TO-USE	103601	MODERATE	An adult female got some of this on her legs. Then 2 days later she developed blisters on her leg. She thought it was just poison ivy. She used a steroid cream on her symptoms and the blisters went away. Then it turned into a big bubble so she went to MD and they gave Death oral steroids. She now has scars on her leg. She was calling to see if it might be related to the product.
022395 - 00001	9/17/2010	FL	071995-00025	ROUNDUP WEED AND GRASS KILLER SUPER CONCENTRATE	103601	MODERATE	An adult male had mixed a total of 15 gallons using Roundup Super Concentrate, dilution of 3 ounces of concentrate per gallon of water to apply over 15 acres. He has a large container on the back of his pickup truck and he used a sprayer hose to spray the Roundup. There was an occasional wind shift and he got the product mist on his skin. He was spraying for approximately 6 hours. He had hives that started in the groin area. His feet began to itch and then he had welts all over. He was

Incident Package Report	Incident Date	Location	Reg Number	Product Name	PC Code	Exposure Severity	Incident Description
							treated with Benadryl and had an appointment with his MD the next day.
022401 - 00001	9/1/2010	LA	000524-00445	ROUNDUP HERBICIDE	103601	MODERATE	Wife calling after being prompted by nurse to question pesticide encephalopathy. Her husband used Roundup 4 days ago. The son brought the product over stating it is Roundup in a spray bottle. The caller does not have the label, ingredients or dilution available. Her husband eyes were swollen the day after use. His symptoms have progressively gotten worse. He started with a headache, now he is disoriented with hallucinations, left arm and leg numbness. The caller has taken her spouse to the hospital 3 times. All CT scans do not show sign of stroke. Her husband's PA just keeps sending them back to the hospital. The man does not take any maintenance medications.
022453 - 00001	10/6/2010	TN	071995-00032	ROUNDUP WEED AND GRASS KILLER-READY TO USE	103601	MODERATE	Caller states that his wife was helping him spray Roundup Ready to Use about 4 weeks ago. She was holding up a sheet of tin foil that they were using to shield plants that they did not want sprayed. No known exposure to the Roundup at that time. Three to four days later, she started with symptoms of a rash on her chest, which has spread to her face. They have gone to their PMD and since have been referred to a dermatologist. She is on Prednisone and various creams. Biopsy of the rash was done this week.
022454 - 00001	########	FL	000524-00445	ROUNDUP HERBICIDE	103601	MODERATE	Ace Hardware employee calling on behalf of a customer who got a mist of an unknown formulation of Roundup in his face about 20 minutes ago. He has developed chest pressure.
022504 - 00001	11/8/2010	CA	000524-00445	ROUNDUP HERBICIDE	103601	MODERATE	Physician office calling about a man that has been using diluted Roundup every day for 3 months while wearing gloves but sometimes touches his face. His skin is red and swollen with blisters.
022805 - 00001	10/1/2010	OH	071995-00023	ROUNDUP WEED AND GRASS KILLER 1 READY-TO-USE	103601	MODERATE	Woman calling in regards to an indirect exposure to a Roundup Weed and Grass Killer product. She had used the product indoors to treat and is now calling due to the eruption of red raised lesion to the back of her leg which occurred following exposure and had then spread to her neck, arms as

Incident Package Report	Incident Date	Location	Reg Number	Product Name	PC Code	Exposure Severity	Incident Description
							well as her waist. The caller stated that she has been in to see dermatology and was given steroid injections which essentially eradicated the condition with only an occasional outbreak. Now she is calling just in case the rash may be related.
022938 - 00002	4/14/2011	PR	000524-00475	ROUNDUP ULTRA	103601	MODERATE	Caller is from Puerto Rico. Spanish translator conferenced on the line. The translator states the caller used Roundup Ultra 2 months ago. He got a spray of the diluted product on his forearm. Since that time, he has been nauseated and had a burning stomach. No oral ingestion. No rashes noted post exposure. No chest symptoms. He has seen a cardiologist. He would like to know what to take to fix these symptoms. MRPC discussed the product toxicity. The symptoms do not correlate with the expected response to the product. Advised to continue under the care of his PMD. MRPC is available to speak to the MD if desired.
022938 - 00004	4/15/2011	NE	000524-00445	ROUNDUP HERBICIDE	103601	MODERATE	Caller states his 14 year old gardener sprayed Roundup last week and broke out in hives from head to toe that evening. The teen had used it all last summer with no reaction. MRPC discussed the product toxicity. The symptom does not correlate with the expected response to the product. Advised to have the family or MD contact MRPC if further concerns.
022938 - 00005	4/15/2011	LA	000524-00445	ROUNDUP HERBICIDE	103601	MODERATE	Son calling, about his 70 year old father who accidently drank less than a mouthful of Roundup about a week ago. The father thinks he spit most of it out. The caller states that they are taking him to the hospital tonight because he is still having symptoms. The caller does not know what the specific product was. He knows that it was a diluted concentrate. The caller states his father's gums and the top of his mouth are sore and painful. His father has been seen once before today. The physician told him that he had 'pus pockets' in his mouth. He also had areas of irritation in his mouth that were bleeding. His father is now complaining that his stomach is hurting. MRPC discussed the product toxicity.

Incident Package Report	Incident Date	Location	Reg Number	Product Name	PC Code	Exposure Severity	Incident Description
							Delayed onset abdominal pain is not an expected response to the product. Advised to observe for worsening of symptoms. On follow up, spoke with the daughter-in-law. The man is in the hospital. Running some tests. The MD thinks it may be some sort of chemical burn. PCC is available to provide information about the active ingredient or consult if the MD desires. No return calls received.
022938 - 00006	4/20/2011	TN	071995-00023	ROUNDUP WEED AND GRASS KILLER 1 READY TO USE	103601	MODERATE	Caller states that on 3/11/11, he was spraying a Roundup Ready to Use product. He felt liquid on his right thigh through his work jeans. He washed the area within 30 minutes. 5 days later he had chills, different muscle twitches. His twitches are mostly gone and his chills are resolved. Now he has a burning sensation at the site for less then a week. The caller is unable to find the ingredients on the label he had saved. MRPC discussed the product toxicity. The symptoms do not correspond with expected response to the product. Advised to follow up with PMD if his symptoms persist or worsen.
022938 - 00007	2/1/2011	CA	000524-00445	ROUNDUP HERBICIDE	103601	MODERATE	Mother of a 27 year old female notes that she believes her daughter's ex-husband may have been poisoning her with Roundup. The last contact with him would have been February and no contact with him since then. The woman states that they have been researching different things and she may have been poisoned by a concentrated type of product. Ate food twice prior to February that tasted strange. MD is involved and not sure of what was ingested or if it is a poisoning or medical problem. Also notes other products such as WD40 come up missing from the home. She complains of hives, mouth burning, stomach upset, poor PO intake, vomiting, diarrhea, and blue nails.
022938 - 00008	4/28/2011	GA	000524-00445	ROUNDUP HERBICIDE	103601	MODERATE	Dad calls about 11 year old daughter who lost some vision in one eye. She is currently in CT scan for evaluation of the eye now. Caller states about a week or 2 earlier, he had sprayed the ground with diluted Roundup. This past Monday night and today, his daughter had planted some flowers. She

Incident Package Report	Incident Date	Location	Reg Number	Product Name	PC Code	Exposure Severity	Incident Description
							may have rubbed her eye with her hand. He is asking if that could affect her vision. MRPC discussed the product toxicity. The symptoms do not correspond with expected response to the product. SPI concerned re: possible misinterpretation of symptoms and/or possible misidentification of product or mixed exposure.
023018 - 00001	5/21/2011	CA	071995-00023	ROUNDUP WEED AND GRASS KILLER 1 READY TO USE	103601	MODERATE	Caller states that she already had a pre-existing case of productive bronchitis. On this past Wednesday, when she sprayed about 3/4th of a gallon of Roundup Ready to Use formulation, her bronchitis turned into wheezing. She did a nebulization treatment that she had in her home. After doing a treatment with no improvement she involved her PMD and is now hospitalized. Her breathing status has gotten worse.
023018 - 00005	5/2/2011	GA	000524-00445	ROUNDUP HERBICIDE	103601	MODERATE	Caller states his brother had been spraying Roundup outside earlier today and ' had a seizure' about an hour ago. No history of seizures before. No product known to be on skin or ingested. The man had diarrhea, a seizure and fell in the bathroom.
023052 - 00001	6/3/2011	TN	000524-00454	HONCHO PLUS HERBICIDE	103601	MODERATE	One month ago, the man was spraying an apple tree using a water mixture of Honcho Plus. He got some overspray on his head and was not wearing a hat that day. He has a raised itchy rash on his scalp. He saw his doctor today who recommended he cut his hair short and recommended a topical treatment. On follow up, 3 days later, the man states, he used hydrocortisone cream as directed. It has helped the itching but the raised bumps are still there. His doctor diagnosed them as seborrheic dermatitis and that he should cut his hair short for it to get better. The Honcho Plus probably did not cause this.
023052 - 00002	6/6/2011	HI	000524-00445	ROUNDUP HERBICIDE	103601	MODERATE	Caller is concerned about her brother who uses Roundup and was just diagnosed with bone marrow cancer. Caller questions if benzene is in Roundup
023052 - 00005	6/22/2011	PA	000524-00454-	GLY-4 PLUS HERBICIDE	103601	MODERATE	Caller states she was misted with water diluted Gly -4 Plus Roundup when she was on a tractor

Incident Package Report	Incident Date	Location	Reg Number	Product Name	PC Code	Exposure Severity	Incident Description
			072693				mowing a neighbor's lawn and man went by spraying at distance away, of a semi-tractor trailer. She could feel the mist on her body and can still see it on her sunglasses that she had on that day. She started to cough and her throat was burning. She stopped and went inside and rinsed out her mouth. She went to an ER that night because she could not stop coughing. She was told she was being treated for chemical burns to her throat and lungs. She was given nebulizer treatments, flovent, albuterol, diphenhydramine x 2 Q 4 hours and steroids. Two days later, she got on the same mower and within 5 minutes the symptoms developed again and she was treated in the ER. About 5 weeks later, she is doing better but her throat is still sore. No known allergies or history of asthma.
023052 - 00006	6/23/2011	FL	000524-00445	ROUNDUP HERBICIDE	103601	MODERATE	Caller states her spouse was exposed to the spray of Roundup when the wind shifted during spraying about 1 year ago. No mask was worn. He has had problems with his breathing and nose bleeds since then. The man bathed after the exposure. He had diluted the Roundup- 2 quarts in 25 gallons of water. Since that time he has had bronchitis. 15 days later he had a nose bleed that bled 5-6 times/day for over a week. The man has a long standing history of nose bleeds since childhood. The ENT MD performed a cauterization. He remained flat on his back for several weeks using nasal gel and antibiotics. About 6-7 wks ago, the man became ill and went to the MD and was given levaquin for treatment of pneumonia, although his lungs were clear. He got better, when the levaquin ran out, his symptoms got worse. He was given prednisone and cough syrup for bronchospasms. His lungs are clear per CXR. When the steroid was gone he got worse again. He is now seeing a pulmonary specialist and given more antibiotics and now has a fever.
023177 - 00001	7/18/2011	CA	000524-00475	ROUNDUP PRO	103601	MODERATE	Caller states he was spraying for approximately 1 week with diluted Roundup Pro. The wind was

Incident Package Report	Incident Date	Location	Reg Number	Product Name	PC Code	Exposure Severity	Incident Description
							blowing, but he did not feel he got any on him. He wore a mask while spraying. He went to the MD for an earache but there was no ear infection. Complaint of a headache and some ataxia.
023183 - 00001	7/2/2011	CO	000524-00445	ROUNDUP HERBICIDE	103601	MODERATE	Caller states 80 year old male who used Roundup yesterday was exposed dermally to the mist. The man did not wash the area with soap and water. The man is experiencing nausea, stomach cramps and chest pain.
023208 - 00001	7/27/2011	TX	071995-00023	ROUNDUP WEED & GRASS KILLER 1 READY TO USE	103601	MODERATE	Caller states she used Roundup Weed and Grass Killer Ready to Use yesterday. The woman states it was very hot and she was sweating a lot. She used a handkerchief to wipe her face. Her eyes started to burn and continued after closing her eyes. She instilled natural tears. Today, she is having trouble seeing, particularly out of one part of her eye. On follow up, the woman states she went to the ophthalmologist, who says she has a scratch on each eye. She has a prescription for erythromycin drops, and one for Tobradex. Her vision was improved.
023262 - 00001	8/23/2011	NC	071995-00023	ROUNDUP WEED AND GRASS KILLER 1 - READY TO USE	103601	MODERATE	Caller states he used Roundup that 'kills poison ivy ' one month ago on some weeds by his home. He states it has rained 3 times fairly hard since that application. Every time he gets out of his car and walks by this area, he states his nose and throat bums. The man called back again for the phone number to the company to inquire how to remove the product from the air. The man called back later, stating he continues to have eye and throat burning in spite of having several hard rains in his area. He states that he can hardly breathe and just feels 'sick'. Unable to name details other than he feels sick. The caller has not phoned his physician or the product line as recommended previously.
023265 - 00001	8/2/2011	IL	000524-00445	ROUNDUP HERBICIDE	103601	MODERATE	Caller states that an unknown formulation of Roundup was sprayed on a weeded area and a bush area in his apartment complex for 2 days in a row. The caller states when he steps outside the door he's affected. He has had no direct exposure to the

Incident Package Report	Incident Date	Location	Reg Number	Product Name	PC Code	Exposure Severity	Incident Description
							Roundup, but he walks by the sprayed areas. He states he cannot get the MSDS from the complex. No air conditioning in the apartment. The caller has a history of epilepsy and is a smoker. He states he has been having seizures everyday since the spraying. He is losing his appetite and has lost 6 pounds since last Thursday. When he spits, blood comes out of his esophagus. The caller states when he does not go on the property, he is fine.
023266 - 00001	8/15/2011	MN	000524-00445	ROUNDUP HERBICIDE	103601	MODERATE	Caller is calling on behalf of her father-in-law. He used Roundup on July 9th. Since then, he started experiencing tingling of his hands, arms, feet and lightheadedness. He keeps touching skin and saying it looks different. The caller cannot see a change in her father-in-law's skin. The man has been evaluated for heavy metals and toxins. His doctor could not find anything wrong with him or no medical cause of these symptoms and advised the man to call the poison center. A CAT scan and MRI and artery testing revealed nothing. The man also seems lethargic and quiet when he used to be full of life. To the caller's knowledge, the man put concentrate in another bottle and added water. He sprayed it in cracks of the sidewalk, around the pool shed. The wind was blowing, so any exposure would have just been from overspray. He showered that day, but it could have been hours after spraying.
023267 - 00001	8/21/2011	MO	000524-00445	ROUNDUP HERBICIDE	103601	MODERATE	ER calling about 22 year old male that arrived by EMS and states he ingested 2 mouthfuls of an unknown formulation of Roundup that was in soda bottle where he is staying about 24 hours prior. Apparently, the man had no complaints until tonight. His tongue is white without ulcerations; the nurse says it looks like thrush on the tongue. His pupils were large, no history of vomiting or diarrhea. En route to ER, EMS reported the man to be posturing and foaming at the mouth. One liter of LR given IV. The man is talking nonstop "all over the place" at this time. The man was admitted to the HCF for seizure precautions and monitoring.

Incident Package Report	Incident Date	Location	Reg Number	Product Name	PC Code	Exposure Severity	Incident Description
							Labs were within normal limits. He had a complaint of his throat being sore and also reported that he did vomit twice but unknown when he actually vomited. The next day the man had no further complaints, stable vital signs, no GLC symptoms or seizure activity.
023361 - 00001	6/22/2011	WA	000524-00445	ROUNDUP HERBICIDE	103601	MODERATE	Caller states that 3 months ago, a lawn care company sprayed an unknown Roundup product on his lawn. A day or a few days later, he worked in the yard on his knees. Later, he thought, he must have had the product soak up through his pants because he developed a blister on his knee. He called his PMD and dermatologist immediately, who were both booked up solid. He went to the pharmacy where they recommended hydrocortisone cream, which he has been using since that time. Symptoms of blistered swollen knee, extending to the waist is present. No itching is noted.
023364 - 00001	9/24/2011	AZ	000524-00445	ROUNDUP HERBICIDE	103601	MAJOR	man intentionally drank 150-350 ml concentrated Roundup Herbicide with vodka; he was found and taken to ER; hypotension requiring vasopressors which resulted in increased lactate leading to metabolic acidosis, evidence of renal impairment. Man showed signs of improvement by day 4 post exposure.
023365 - 00001	9/12/2010	CA	000524-00445	ROUNDUP HERBICIDE	103601	MODERATE	Man calling is 44 years old, with a history of a traumatic brain injury in 2006 which has resulted in balance and equilibrium issues. He has difficulty walking which has worsened over the last year with increasing muscle spasms to the point he can no longer walk. His symptoms are similar to those of MS. He recently learned that the marijuana he had smoked 8 to 12 months ago had been killed with Roundup.
023531 - 00001	6/14/2011	NM	000524-00517	RANGER PRO	103601	MODERATE	Nurse practitioner calling from a PMD office where a 67 year old male is being seen for the third time in the recent past. He has been using Ranger Pro 8 to1 0 times between 3 to 5 months ago. The last time he used the product was about 3 months ago. He dilutes the product 5 ounces into 1 gallon.

Incident Package Report	Incident Date	Location	Reg Number	Product Name	PC Code	Exposure Severity	Incident Description
							He did get the diluted product on his ankle 5 months ago. He was wearing shoes (not sandals) with no socks. He did not wash off until the next day with his normal morning shower. He had a stripe of redness on the top of his left foot and developed joint pain of his left ankle. Since that time he has had hives on his right forearm, a red raised rash of his axilla area. He has been on a medrol dose pack.
023532 - 00001	########	CA	000524-00445	ROUNDUP HERBICIDE	103601	MODERATE	Caller states his 82 year old dad was mixing one of the concentrate Roundup products with water 6 months ago and spilled some on his finger but did not wash it off right away. Unknown if he spilled the concentrate or the dilution on his finger. Blisters appeared on the finger but the caller does not know the time frame of onset. Since then, he has had a burning pain in the finger. The skin is now completely normal.
023577 - 00001	8/6/2011	NEW ORLEANS, LA	042750-00061	GLY STAR PLUS	103601	MINOR	An adult male got the product in his eye. He experienced vision problems. He went to three MDs. He was not able to resolve his symptoms.
023628 - 00001	########	BROKEN BOW, OK	042750-00060	GLY STAR ORIGINAL	103601	MODERATE	An adult male got the product in his eye. He experienced vision problems.
023704 - 00001	12/8/2011	CAPE CORAL, FL	042750-00061	GLY STAR PRO	103601	MINOR	An adult male go the product on his hands. He did not rinse his skin right away. His skin became dried and cracked.
023710 - 00001	1/23/2011	WV	000524-00445	ROUNDUP HERBICIDE	103601	MODERATE	Woman calls from West Virginia about her exposure to an unknown formulation of Roundup one year ago. She was sitting on Main Street on a windy day when she noticed a misting on her face and skin. At the same time, the railroad was applying Roundup to the weeded areas on their property. She came home and called the railroad office to see what they were using and was told 'Roundup' but no particular formulation. She feels she was 'heavily sprayed' but showered within 1-2 hrs of the exposure when she got home. The only concern she offers is that her skin seems like it was 'burned' in several places and has been peeling.
023821 - 00001	10/1/2011	MI	000524-00445	ROUNDUP ORIGINAL	103601	MODERATE	5 crew members were in a field in MI doing a survey project. The field was adjacent to a farm. A

Incident Package Report	Incident Date	Location	Reg Number	Product Name	PC Code	Exposure Severity	Incident Description
							contractor sprayed 2 fields next to workers with roundup. Workers had multiple symptoms. Headache, nausea, burning of eyes, nose, throat, metallic taste in mouth. Decontaminated within 1 hour of exposure. Symptoms resolved 1.5 hours after decontamination.
023906 - 00001	3/31/2012	IN	000524-00445	ROUNDUP HERBICIDE	103601	MODERATE	Caller states he was spraying an unknown formulation of Roundup that was diluted to a stronger strength than what is instructed. The sprayer hose came off and sprayed the product in his mouth, face and eyes an hour ago. He showered and flushed his eyes for 30 minutes. He has rinsed his eyes every 15 minutes since then. His eyes are burning. He drank 2 glasses of chocolate milk. He is calling now because he is dizzy and feels his speech is slurred. Adequate dermal, PO and ocular irrigation were performed.
024028 - 00001	4/21/2012	MO	071995-00023	ROUNDUP WEED & GRASS KILLER 1 READY TO USE	103601	MAJOR	Caller notes that on Monday his wife was out spraying with some type of Roundup Ready To Use. It spilled and made the back of her shirt wet. On Friday, they found out that she experienced a miscarriage. The caller is asking if this was related to her exposure on Monday.
024028 - 00002	4/20/2012	MO	071995-00023	ROUNDUP WEED & GRASS KILLER 1 READY TO USE	103601	MODERATE	Caller states this past Tuesday afternoon, his wife began to have involuntary movements of her left arm and leg, which now looks as if it is moving to her right side, and her speech and thought process were altered. The caller phoned her PMD who referred her into an ED and she was admitted to the hospital. She has had a stroke work up, CT scan and MRI. The caller is inquiring about the use of Roundup.
024172 - 00001	5/18/2012	OK	071995-00016	ROUNDUP SURE SHOT FOAM	103601	MODERATE	Caller states she used a whole container of Roundup Sure Shot Foam last evening on the weeds when some came back on her. She did not think much of it and did not take a shower until later that night. She has used Roundup in the past without any problems. The caller is covered with hives from her waist to her knees. No trouble swallowing and no swelling. MRPC discussed the product toxicity. Possible allergic reaction to an

Incident Package Report	Incident Date	Location	Reg Number	Product Name	PC Code	Exposure Severity	Incident Description
							ingredient if the woman is hypersensitive. The woman is planning on going to the ER for treatment. She does not have any Benadryl at home. On follow up, the woman was taking Benadryl and applied Caladryl. The woman is feeling better and her symptoms are improving. Woman states it was a windy day and she may have inhaled some of the mist.
024172 - 00003	5/17/2012	MD	071995-00032	ROUNDUP READY TO USE POISON IVY AND TOUGH BRUSH KILLER 2	103601	MODERATE	Man calling to rule out all causes of his symptoms of shortness of breath and nausea that he has experienced for the past 1 week. He has been to the ER and the symptoms are non cardiac related. Last week, he used an old bottle of Roundup Poison Ivy and Brush Killer RTU formula. The bottle was in the garage for a few years. The sprayer leaked and got on his hands and arms for 5 minutes only. He washed off promptly. MRPC discussed the product toxicity. The symptoms do not correlate with the expected response to the product.
024172 - 00007	5/16/2012	ID	000524-00445	ROUNDUP HERBICIDE	103601	MODERATE	Ophthalmologist calling with vague details. He is seeing an adult male, who got Roundup splashed into an eye a couple of days ago. Unsure of the exact Roundup product or if a concentrate or diluted formulation. He is unsure if there was even an ocular exposure to Roundup. No irrigation done by the man at the time of the exposure. His eyelid is very swollen and part of his cornea has come off. MRPC discussed the product toxicity. The symptom does not correspond with the expected response to the product. Caller declined to have the product information faxed to him or to give information on the person that was exposed.
024172 - 00008	5/21/2012	IA	000524-00445	ROUNDUP HERBICIDE	103601	MODERATE	Caller states that her husband had been spraying an unknown formulation of diluted professional Roundup on the farm this past Thursday. He got some on his hands and did not wash if off for about 5 minutes. On Thursday evening into Friday morning he began to have tightness of his chest and he broke out into hives. He went to the ED and had a cardiac work up which was negative. He took Benadryl for the hives and they dissipated. Today

Incident Package Report	Incident Date	Location	Reg Number	Product Name	PC Code	Exposure Severity	Incident Description
							he started with the hives again and in addition he is having swelling of his hands and feet. MRPC discussed the product toxicity. The symptoms do not correspond with the expected response to the product. Advised to stay under medical care of MD.
024172 - 00009	5/30/2012	MO	000524-00445	ROUNDUP HERBICIDE	103601	MODERATE	RN calling from ER about a farmer, who had been spraying with an unknown formulation of Roundup for a couple of hours about 3.5 hours ago. Afterwards, he was talking to a friend, and started having slurred speech and according to his friend, he seemed to "zone out for a minute". RN states since arrival to the ER, the man has been awake and alert, oriented x 3, vital signs have been stable and within normal limits. No slurred speech noted. MRPC discussed the product toxicity. The symptoms are not consistent with the expected response to the product. The man was discharged to home within a few hours of arrival.
024222 - 00001	4/25/2012	PR	000869-00238	GREEN LIGHT COM-PLEET 41% SYSTEMIC GRASS & WEED KILLER 2	103601	MODERATE	A male used the product and experienced an all over body rash. He was seen by a medical facility and subsequently was treated the rash. The medical facility advised the rash would go away and the caller should have no lasting effects from the rash. Caller wanting to know if this is truthful information from the medical center. One week later he still had the rash.
024294 - 00004	6/5/2012	MO	000524-00454	BUCCANEER PLUS HERBICIDE	103601	MODERATE	Caller used Buccaneer Plus yesterday that he mixed in a 30 gallon sprayer to pull behind his lawnmower. He mixed 1/2 gallon of the solution in 25 gallons of water. No mishaps, although may have been exposed to some of the overspray. He does not recall significant wetness of his skin or clothes from the Buccaneer. He also burned a citronella type candle in his home last night. He broke out in hives last night with mild itching. He took a Loratadine 10 mg tablet earlier today.
024294 - 00005	6/20/2012	TX	000524-00475	ROUNDUP PRO	103601	MODERATE	Nurse calling from an occupational clinic about a 44 year old male who had an exposure to diluted Roundup Pro 30 minutes ago. The man was getting ready to use his rig he had prepared 2 days prior for

Incident Package Report	Incident Date	Location	Reg Number	Product Name	PC Code	Exposure Severity	Incident Description
							spraying. It had Roundup Pro inside the tank diluted 34 oz to 55 gallons of water. He went to turn it on and the hose popped off and sprayed him in his face, eyes and chest area. He had safety goggles on. They have been rinsing his eyes for 15 minutes. He is complaining of a skin burning sensation and throat irritation. On follow up, the nurse states the man complains of slight blurring of vision. On further follow up, it was noted that the man had a corneal abrasion. He was given eye drops and discharged to home.
024309 - 00002	6/18/2012	OROVILLE, CA	042750-00061-002217	PRONTO BIG N' TUF	103601	MODERATE	A 47 year old male was exposed to product and symptoms (dizziness, vertigo, coughing, choking) started that evening. The product was sprayed into ground, he then shoveled the dirt and may have inhaled dust and also had dermal exposure
024371 - 00001	7/13/2012	IL	000524-00445	ROUNDUP HERBICIDE	103601	MODERATE	Caller states a family member has been sick for about a week with breathing problems. He has been to the hospital and had prednisone and other drugs prescribed without improvement. COPD was diagnosed. The man has had some breathing issues in the past, but his symptoms got worse suddenly and quickly. About a week or two ago, the man accidentally got an unknown concentrate Roundup, diluted for use, on his skin. It splashed over the front of him and his face. He took a shower immediately. His symptoms began about one week later. No known cough or choke at the time and no other symptoms noted at the time of the exposure.
024372 - 00001	7/10/2012	TN	000524-00529	ROUNDUP PRO CONCENTRATE HERBICIDE	103601	MODERATE	Man calling with a concern about a Roundup exposure. About 2 months ago, he sprayed a 2% water dilution of Roundup Pro Concentrate and then was lying on the ground, possibly in the area just sprayed. Shortly after this exposure, the man reports he developed joint and muscle pain enough to warrant going to the doctor.
024486 - 00008	2/5/2009	ST. GABRIEL, LA		ROUNDUP	103601	MAJOR	Exposure to "Roundup" in her employment at Syngenta in St. Gabriel, LA. Child was allegedly born with defects that include developmental and respiratory abnormalities. Date of birth is

Incident Package Report	Incident Date	Location	Reg Number	Product Name	PC Code	Exposure Severity	Incident Description
							unknown.
024486 - 00011	8/23/2012	LA	000524-00445	ROUNDUP HERBICIDE	103601	MODERATE	Woman calling is concerned that her next door neighbor is overusing Roundup used in quantity. She noticed this summer that after he sprays she has an expiratory wheeze. She went to her doctor who prescribed an inhaler that helps. She did not do the spraying nor did she feel any spray mist on her skin when she was out working in her garden when he was spraying. MRPC discussed the product toxicity. The symptom does not correlate with the expected response to the product.
024486 - 00012	8/27/2012	KY	000524-00445	ROUNDUP HERBICIDE	103601	MODERATE	Man calls with concerns about his neighbor's crop spraying applied liberally by a tractor 4 months ago. He was outside during some of the application exposed because the rpm's were increased on the tractor vaporizing the Roundup making it difficult to avoid exposure. The caller states the neighbor did it on purpose. The caller thinks they used Roundup but the state testing has been inconclusive and was covered up. A state lawyer was involved. He states he feels ~c o'(became sick shortly after starting with constipation, liver problems, sinus infection, gum infection, boils, lost two teeth, woke up with his bones separated in his foot shortly after the spraying. He went to the doctor who felt his back and dental issues are the cause of the problems. The farmer told the state inspectors that Roundup was used. The caller states since he worked with the pipeline in the 1950s and 1960s he probably mixed some other chemicals with it. The man would like to know if there are any antidotes for Roundup poisoning. MRPC discussed the product toxicity. The symptoms are not related to the expected response to the product. Advised to remain under the care of MD.
024486 - 00013	8/29/2012	MO	000524-00445	ROUNDUP HERBICIDE	103601	MODERATE	MD calling from the emergency department about a child who spent the day supervised by parents and most of that time was on an ATV. Parents were working on the farm and moving cows. Parents were also spraying weeds with 2,4-D and Roundup.

Incident Package Report	Incident Date	Location	Reg Number	Product Name	PC Code	Exposure Severity	Incident Description
							Child did not have any direct contact with the herbicides. Child had unpasteurized milk for the first time as well today. No witnessed ingestions of any plant material and no meds/drugs available. Child presents with a dry mouth, agitation, delirium, nystagmus, HR 150 ST, minor hyperthermia, flushed appearance. MRPC discussed the product toxicity. The symptoms do not correlate with the expected response to the product. Continue with symptomatic care and further history of possible exposure to other substances or medications.
024494 - 00019	8/13/2012	WA	071995-00007-000239	ORTHO TOTAL KILL WEED & GARDEN KILLER CONCENTRATE HERBICIDE	103601	MODERATE	Caller is a physician assistant. He has a patient who was exposed to this product about 40 minutes ago. He complains of pain. Caller reports ocular irritation. He flushed his eyes for only 10 minutes prior to presentation. At this time, P. K., a male patient, is having his eyes flushed again for a longer period of time. Caller has not done a slit lamp exam on this patient yet. After flushing, he will do that and refer to ophthalmology as needed. His eye was irrigated. No damage seen on slit lamp exam. He was prescribed an antibiotic drop. Was then released and comfortable at discharge.
024551 - 00001	9/13/2012	DE	071995-00017	ROUNDUP CONCENTRATE WEED AND GRASS KILLER 1	103601	MODERATE	Caller states she was outside, when her nephew was spraying Roundup, an 18% formulation, that had been diluted. She was near the area being treated when she felt like her throat was closing up. The caller states she is chemically sensitive. About 1.5 weeks later, she noted her eye and the side of her face along her hair line looked scalded. Her eye lid was red and puffy. It would then flake and peel. She had some ocular redness and swelling that has seemed to resolve. She was seen by her PMD and treated with oral steroids. The symptoms resolved but have come back. Now, she is being managed by an ophthalmologist and has been diagnosed with blephritis. She is currently on minocycline orally, but had previously used tobradex to the eye and eyelid. The caller suspects a relationship with the Roundup and wondering

Incident Package Report	Incident Date	Location	Reg Number	Product Name	PC Code	Exposure Severity	Incident Description
							what treatment should be considered.
024691 - 00001	8/2/2012	JASPER, AL	001381-00192	CORNERSTONE PLUS	103601	MODERATE	A male farm worker unintentionally drank some Cornerstone Plus that was in a water cooler. He experienced bloody diarrhea and was diagnosed with colitis.
024948 - 00001	1/3/2013	OH	000524-00445	ROUNDUP HERBICIDE	103601	MODERATE	The caller wants to know if it is possible for a person to harm himself with Roundup concentrate. Someone has drank some and is unconscious. The caller wants to know if it is possible that Roundup concentrate is the cause.
025087 - 00001	3/19/2013	CO	000524-00445	ROUNDUP HERBICIDE	103601	MAJOR	Monsanto/Scott company calling about an older female who has sent an e-mail or letter to the company claiming exposure to Roundup Concentrate has caused Parkinson's disease. The woman stated that her exposure was "dipping her hands in a Roundup solution."
025157 - 00001	4/25/2013	OH	000524-00445	ROUNDUP HERBICIDE	103601	DEATH,MAJOR	An adult female emailed about a study she read on tumors in rats exposed to Roundup. Her husband & a neighbor both died of tumors. She and husband were exposed to Roundup 3 years ago and both developed tumors. She is concerned about her own health. She provided no phone number. Monsanto emailed a response and asked her to contact them but she didn't. Exposure to Roundup is not clear.
025228 - 00001	4/14/2013	CA	000524-00517	RANGER PRO	103601	MODERATE	Caller states that about 30 minutes ago she poured some Ranger Pro Herbicide into a measuring cup for her husband to dilute the product. She started to feel weird and to wheeze. Caller states that more than 20 years ago, she was spraying a Wilson Leather Protectant product and inhaled some resulting in 70% lung capacity and now she seems to be very sensitive to chemical smells. She went inside and used her inhaler and is feeling better.
025233 - 00001	4/26/2013	ID	000524-00445	ROUNDUP HERBICIDE	103601	MODERATE	Caller states he has just put all the pieces of this together, and before he sees a doctor he wants information. He states someone sneaked in during the middle of the night several months ago and poisoned his apricot tree and other trees. He then ate the apricots. He thinks it was a neighbor lady, who has passed away now, but he saw a Roundup container at her house before she departed. He has

Incident Package Report	Incident Date	Location	Reg Number	Product Name	PC Code	Exposure Severity	Incident Description
							symptoms of weakness in his lower extremities and numbness to his feet and legs.
025234 - 00001	4/19/2013	GA	042750-00061	GLY STAR PLUS FROM AGRI STAR	103601	MODERATE	Caller states that about a month ago he was using Gly Star Plus and got some of the concentrate on his hands. He rinsed it off right away but then realized the concentrate had been on the handle of the sprayer he was using. Two days after the exposure, he had flu like symptoms, profuse watery diarrhea, nausea, vomiting, and abdominal pain. He now has periods of itching all over and small red bumps noted on his chest. When he sits down and then gets up he gets chills up and down his legs. He has not seen a doctor for his symptoms yet.
025309 - 00001	2/1/2013	KY	071995-00023	ROUNDUP WEED AND GRASS KILLER1 READY TO USE	103601	MODERATE	Caller states she used a ready to use Roundup 3 months ago while wearing shorts. She assumes some of the mist got on her legs. She did not shower afterwards. Two days later, she developed a rash that looked "like bites" or tiny bumps on the front of her legs. She went to her primary MD who gave her an antibiotic and steroid combination cream. She used it, and the rash faded but came right back. It is very pruritic. She went to one dermatologist that she feels was just "guessing" about the rash and has an appointment for next Wednesday with another dermatologist. The caller states she has used Roundup for years and never had a problem until this time.
025312 - 00001	5/1/2013	FL	000524-00445	ROUNDUP HERBICIDE	103601	MODERATE	Caller states that 4 weeks ago, she was riding a cart at a golf course when she got covered with the spray of a Roundup product from a truck that was in front of her. The caller says that she must have inhaled the Roundup, because she has had a cough since that time. Occasionally mucous comes up with the cough. In speaking with the caller, the cough is intermittent. A few times a day she has had a runny nose that pre-dates the exposure. The woman has not sought any evaluation or treatment by a MD.
025314 - 00001	5/14/2013	MO	000524-00445	ROUNDUP HERBICIDE	103601	MODERATE	Caller states that she was exposed to Roundup earlier today around noon time, and is now "very sick". She states that her neighbor sprayed

Incident Package Report	Incident Date	Location	Reg Number	Product Name	PC Code	Exposure Severity	Incident Description
							Roundup in her yard to try to kill her. The neighbor told her that she was "a weed that needed to be gotten rid of'. The caller states she inhaled some of the product when she was in her yard as he was spraying it. She thinks her neighbor was using one of the concentrated products, but is not sure exactly which one. The caller complains of throat irritation, palpitations, trouble breathing, and "very sharp" chest pain. On follow up, the woman was observed and monitored for several hours and had been discharged to home.
025315 - 00001	5/22/2013	IN	000524-00445	ROUNDUP HERBICIDE	103601	MODERATE	Caller states that last week her husband used a weed killer. There are three different weed killers in their garage, she is unsure of which product he used. The caller states that her husband is hospitalized with an infection and 2 blood clots in his leg and is concerned that this could be caused by Roundup getting into a cut that he had on his arm while using the weed killer. Unknown the type of infection or if the infection is in his arm wound. He is currently receiving antibiotic therapy.
025316 - 00001	5/26/2013	CO	000524-00445	ROUNDUP HERBICIDE	103601	MODERATE	Man used an unspecified formula of diluted Roundup concentrate for about 2 hours. There was a little wind on that day. He got some on his hands as he mixed it. No accidents during spraying. Denies working with any poison ivy/oak. He showered with soap and water within an hour of finishing his spraying. He has not used Roundup before. No new soaps or foods. The only thing different over the last 3 days is, he has been using his Ventolin HFA inhaler that he was prescribed during a bout with pneumonia this past year. No difficulty breathing or wheezing is reported. The Roundup was mixed 6 ounces to 2 gallons of water. The next day, a raised itchy rash started on bilateral arms, worse on forearms, some on top of hands, on both ankles above his socks, and neck. All these areas of skin were exposed during the use of the product. He has started using topical hydrocortisone cream. On follow up, the man stated after he took a dose

Incident Package Report	Incident Date	Location	Reg Number	Product Name	PC Code	Exposure Severity	Incident Description
							of the Benadryl, his itching had resolved and he was feeling well and going back outside to do more yard work. On further follow up, the man said later that evening, he went to the ER for worsening of symptoms. He was advised by the MD to continue taking Benadryl, and was prescribed prednisone and Pepcid. The hives and itching were clearing. He was diagnosed with Urticaria/hives secondary to environmental allergies.
025347 - 00005	3/6/2013	CA		ROUND UP CONCENTRATE	103601	MODERATE	An individual has been hospitalized after drinking Round Up (active ingredient: Glyphosate).The patient stated that he accidently ingested the Round Up Concentrate that was stored in the garage. The patient had purchased the Round Up Concentrate at Home Depot about a month ago and after use stored the remaining pesticide in a V-8 Juice bottle in the garage. He drank out of the V-8 bottle thinking it was juice. Once he realized what he drank was not V-8 Juice, he rinsed his mouth with water and mouthwash but did not tell anyone what had happen since he did not feel any symptoms. At about 7 pm the same day, he began to feel ill with throat pain and told his wife what had happened that morning. The wife transported him to the Kaiser Permanente hospital where he was admitted for treatment.
025424 - 00001	6/17/2013	TX	000524-00445	ROUNDUP HERBICIDE	103601	MODERATE	Adult female calling about possibly pulling weeds on that her husband had sprayed with Roundup the day before. Her hands were red the evening after pulling the weeds. The next day, her hands were swollen and she developed hives everywhere. She went to the ER and was given steroids and was better. Today, she went back to the ER because of difficulty breathing.
025583 - 00005	7/1/2013	NJ	000524-00445	ROUNDUP	103601	MODERATE	Neighbor sprayed caller's property sometime before the weekend getting an unknown formulation of Roundup on her fig trees. The leaves on the fig are not withered but are not as robust as usual. Family members enjoy the fruit,

Incident Package Report	Incident Date	Location	Reg Number	Product Name	PC Code	Exposure Severity	Incident Description
							peeling it before eating. On Saturday, the caller, her adult son, his friend and his friends 6 month pregnant wife helped her cut down the fig tree and carry the plant branches to a dumpster. Of all the 4 people who cleared the fig tree the son's male friend (who is allergic to everything) had bronchospasms for which he needed a breathing treatment in an ER. He was discharged to home and is fine now. It is unconfirmed whether Roundup was actually on the fig tree.
025583 - 00006	7/19/2013	FL	000524-00445	ROUNDUP	103601	MODERATE	Caller states that her neighbor was using a diluted Roundup product in her own sprayer. Something happened with the hose and she ended up getting diluted Roundup into her eye about 20 minutes ago. Prior to calling, she did attempt to irrigate her eye using an eye cup. Her eye is still burning and stinging. On follow up, the woman stated she had a foreign body sensation. She was referred to her ophthalmologist for an eye exam and treatment. She was diagnosed with a corneal burn to the corner of her eye. She was prescribed antibiotic and steroid drops and is scheduled to follow up with the ophthalmologist.
025583 - 00008	7/31/2013	CA	071995-00025	ROUNDUP WEED AND GRASS KILLER SUPER CONCENTRATE	103601	MODERATE	Woman calling regarding herself, stating she has been having "stomach issues" and works with Roundup frequently. She says that she has accidentally drunk some diluted Roundup but her signs and symptoms have been going on for about 3 months now. Caller says that the "cancer meds" she is taking could also be the cause of her symptoms.
025583 - 00009	7/17/2013	IL	071995-00023	ROUNDUP WEED AND GRASS KILLER1 READY TO USE	103601	MODERATE	Caller states 7 4 year old male in good health, was picking weeds, 1 year ago, from a garden not knowing his wife had sprayed with Roundup Ready to Use. He was not wearing gloves but washed his hands after pulling the weeds. Since then, he has had an itching rash on the inside palm of his right hand. It feels tender and is sensitive to touch. "Cold water will irritate". He has been to a few dermatologists and has taken corticosteroids. Recently, he was given Flucanozole in case it is a

Incident Package Report	Incident Date	Location	Reg Number	Product Name	PC Code	Exposure Severity	Incident Description
							fungus infection
025583 - 00011	7/1/2012	NJ	000524-00475	ROUNDUP ULTRA	103601	MAJOR	A nurse in New Jersey asked to speak with someone about Roundup Ultra and a strange illness her brother-in-law has had for a year now. She stated that he has a farm and used Roundup Ultra and doctors cannot find anything wrong with him but to say his body may have had an allergic reaction from using the Roundup product. His blood work shows nothing but his body has been swollen and she fears he doesn't have much time left.

Appendix 3

SENSOR-Pesticides 1998-2009 Moderate & High Severity Glyphosate Cases			
Case ID	Year	Severity	Case Description
CA15534	2008	High	Roundup drifted onto officer as he was responding to an accident on the side of the freeway
FL02294	2007	High	45 y/o man was spraying product and hose started leaking and product spilled on both hands. Did not wash immediately.
FL02346	2007	High	Male has been using high yield zawl for almost a month.
FL03304	2009	High	Patient is suspected of trying to commit suicide by ingesting an unknown amount of roundup weed and grass killer concentrate
LA00205	2001	High	mother bought pest. from man in neighborhood; stored in v8 container; mentally ill brother used pest. to make choc. milk
NC01758	2009	High	Man ingested roundup from an antifreeze bottle with beer or wine Caller is EMS has man who has ingested 8-16 oz of Roundup from an antifreeze container and alcohol. He has symptoms of vomiting several times, hypotension, blood pressure drop, acidotic, respiratory arrest apnea, has developed wide complex tachycardia. His prior medical history is negative.
CA02204	1998	Moderate	Not Available
CA03535	1998	Moderate	Not Available
CA03640	1998	Moderate	Not Available
CA03704	1998	Moderate	Not Available
CA04445	1999	Moderate	Not Available
CA05234	1999	Moderate	Not Available
CA05260	1998	Moderate	Not Available
CA05563	1999	Moderate	Not Available
CA06363	1999	Moderate	Not Available
CA07993	2000	Moderate	Not Available
CA09242	2001	Moderate	Not Available
CA09383	2001	Moderate	Not Available
CA09779	2001	Moderate	Not Available
CA10137	2002	Moderate	Not Available
CA11225	2002	Moderate	Not Available
CA13383	2003	Moderate	Not Available
CA13488	2003	Moderate	Not Available
CA14027	2004	Moderate	He used a new weed spray and broke out in rashes the next morning
CA14187	2002	Moderate	Works spraying chemicals, now has a rash
CA14302	2005	Moderate	Round-up got in both eyes
CA14626	2006	Moderate	Developed red burning marks and blisters on his chest, back, and arm after using chemicals at work.
CA15535	2008	Moderate	Wearing a backpack sprayer and it leaked

SENSOR-Pesticides 1998-2009 Moderate & High Severity Glyphosate Cases			
Case ID	Year	Severity	Case Description
CA15626	2008	Moderate	Hose malfunctioned and leather gloves were soaked with glyphosate
CA15644	2008	Moderate	The hose of a sprayer broke and splashed his face/eyes
CA15707	2008	Moderate	Confused, mixed roundup with soda and drank it
CA15957	2008	Moderate	Backpack sprayer leaked
FL00379	1998	Moderate	While applying glyphosate, complainant cut her arm on a tree branch. The chemical irritated and burned the cut tissue.
FL00621	1999	Moderate	Dockworker alleges pesticide drifted onto him after a pesticide application. He was neck deep in water at the time.
FL01328	2004	Moderate	Neighbor applied pesticide at fence line. Residents were exposed and got ill.
FL01531	2006	Moderate	26y/o male admits to ing approx 8oz of Round up concentrate plus weed/grass killer
FL01588	2006	Moderate	Patient worked with chemical for a few days at high levels. Not wearing protective gear.
FL01671	2006	Moderate	Patient was exposed to open container of round-up at work
FL01930	2006	Moderate	Patient was spraying round up in his yard and got some in his eyes.
FL02292	2007	Moderate	9 year old was sprayed in eye by a herbicide.
FL02375	2007	Moderate	Landscaper was exposed to glyphosate to days ago.
FL02521	2007	Moderate	Male was working on yard and spraying product. Some product got on hands.
FL03631	2009	Moderate	Not Available
LA00998	2003	Moderate	Drift from aerial application to sugar cane field behind home. Plane was spraying Polado herbicide (glyphosate) Walking in yard and noticed an aerial application to sugar cane field behind home. SX of headache, SOB, eye irritation, and abdominal pain. Complainant called sheriff and was taken to ER for treatment.
LA01692	2005	Moderate	Got round up in eyes at work; cleaning tank; backsplash into face and eyes
LA02721	2007	Moderate	mixed (clorox + roundup concentrate plus weed and grass killer)then spilled on arm; dermal irritation
LA03061	2008	Moderate	child at aunt's house yesterday was sprayed in face with (maxide ready-to-use grass and weed killer)
MI00036	2001	Moderate	working in field, spraying roundup, when wind shifted. Sprayed on field, unknown type of sprayer.

SENSOR-Pesticides 1998-2009 Moderate & High Severity Glyphosate Cases			
Case ID	Year	Severity	Case Description
MI00276	2003	Moderate	Mixture of pesticides spilled in storage room. He has history of industrial asthma & when he walked by, could not breathe.
MI00397	2005	Moderate	Farm exposure to mixture of roundup, ammonium sulfate, & liquid nitrogen. Flushed eyes & arm before going to ED.
MI00583	2005	Moderate	Was trying to unclog pump, got some spray in her eye. Rinsed with hose at work.
MI01980	2009	Moderate	Not Available
NC00086	2007	Moderate	Woman purposefully ingested Roundup at home. 30 year old woman intentionally ingested Roundup Brushkiller Concentrate on 04/19/2007. Somebody from her house called Poison Control. The patient started vomiting and had a strong abdominal pain. She was taken to a nearby hospital and was admitted to the critical care unit. According to surveillance program records, the patient was still in hospital on 04/20/2007 but her condition was improved.
NY00313	2000	Moderate	Woman was working in her garden using a pump bottle of ready-to-use Roundup herbicide. Woman was working in her garden using a pump bottle of ready to use Roundup Lawn & Grass herbicide. She did not follow instructions & was not wearing protective clothing, eye wear or gloves. She states that she was sprayed as there was a drift wind and also she states that the trigger pump was leaking down her hand & wrist.
OR01583	2007	Moderate	Splashed glyphosate in both eyes after turning on high-pressure hose.
TX01850	2000	Moderate	Case is a farmworker/licensed pesticide applicator and had been spraying round-up near cotton fields for approximately 2 week
TX02115	2000	Moderate	Case mixes and applies round-up daily as part of job on ranch. Wears no protection and contact is common. Developed painful
TX04618	2005	Moderate	Case was putting bottle of roundup on top shelf, bottle fell over splashing case in face & eyes.
TX05736	2008	Moderate	case exposed to herbicide at work while spraying weeds and brush along a city road; wind caused spray to blow back at him.
WA00936	2002	Moderate	40 y/o female employee of Walmart reported a skin rash/irritation following contact with a herbicide. She was stocking the shelves when exposed. About 9 days later she sought medical attention.
WA01571	2004	Moderate	A 43 y/o female was applying an herbicide and was sprayed in the right eye from a cracked nozzle assembly. She washed with running water for 10-15 minutes and still developed ocular pain. She sought medical attention the same day.
WA02644	2007	Moderate	A 21 y/o male landscaper worker, according to medical records, inhaled fumes while spraying plants. He developed symptoms and presented at clinic with respiratory, G.I., cardiovascular, neurological and dermal symptoms one day after exposure. He was treated and released, returning again to clinic next day. Patient was lost to follow-up and employer did not supply spray records as requested.

SENSOR-Pesticides 1998-2009 Moderate & High Severity Glyphosate Cases			
Case ID	Year	Severity	Case Description
WA03234	2009	Moderate	A 40 y/o male tractor driver developed respiratory symptoms and eye irritation after he drove the tractor disking soil in the vineyard behind a boom sprayer applying herbicide. The tractor driver wore a face mask. He went to the emergency department and continued to seek medical care afterwards for asthma-like symptoms. He had a history of environmental allergies but no prior history of asthma. The herbicide was applied to the vineyard eleven times over a 5-week period.

Appendix 4

Glyphosate: Literature Review Methodology

To identify the epidemiological investigations of the association between glyphosate exposure and adverse health effects, we queried PubMed/Medline and the Institute of Scientific Information's Web of Science. We also performed limited searches using Google.Scholar. Querying these three search engines is considered a comprehensive way to identify relevant articles (Falagas, 2008). PubMed is the most commonly used biomedical search engine used by researchers today, however Web of Science offers similar journal coverage in addition to citation mapping capabilities. We performed citation mapping using Web of Science, examining key articles which referenced the articles included in the literature review, to identify additional relevant material. We also sought relevant articles through Googel.Scholar. These methods are discussed herein.

We generated the following search strings. Emphasis was placed upon identification of all possible epidemiological studies available, and the ability to use the identical search string in both PubMed/Medline and Web of Science. Regarding Google.Scholar, we attempted use of similar search strings as well as the advanced search capabilities available [http://scholar.google.com/advanced_scholar_search?hl=en&as_sdt=20000].
The search strings are found below:

> PubMed: (((Glyphosate[tw] OR (N-(phosphonomethyl)glycine[tw]) OR gliphosate[tw] OR Roundup[tw] OR yerbimat[tw] OR (glyphosate hydrochloride (2:1)[tw]) AND (humans[tw] AND (epidemiologic studies[tw] OR cohort*[tw] OR case control[tw] OR cross section*[tw] OR cluster*[tw] OR environmental exposure*[tw] OR occupational exposure*[tw] OR ecologic stud*[tw] OR aggregate stud*[tw])))
> Web of Science: ((((Glyphosate OR (N-(phosphonomethyl)glycine) OR gliphosate OR Roundup OR yerbimat OR (glyphosate hydrochloride (2:1))) AND human AND (epidemiologic stud* OR cohort* OR case control OR cross section* OR cluster* OR environmental exposure* OR occupational exposure* OR ecologic stud* OR aggregate stud*))))

We did not restrict the date of publication; however with a few exceptions most studies identified were published 1990-present. After elimination of duplicate references between the two search engines, we identified 90 research articles of potential interest. For inclusion in this review, articles were published in English language, analytic epidemiologic investigation, and included a glyphosate risk estimate. Among the 59 articles excluded from review at this point in the search process, 12 were evaluation of human exposure only, 16 related to an acute pesticide poisoning incident(s), 8 articles concerned evaluation of ecological exposure (non-human) only, 7 were experimental toxicological studies and 6 were review articles or editorials (not original research) or did not meet inclusion criteria for other reasons. Therefore, there were 31 full-text original epidemiological research articles of an association between glyphosate exposure and an adverse human health outcomes included in full-text review, and 10 were included in the HED review. There were 21 articles excluded as a result of full-text review (14 exposure-only, no epidemiological risk assessment; 6 review articles; and 1 toxicological study).

Citation mapping included review of two high-quality summary articles of the investigation into glyphosate toxicity in the human population (Mink et al., 2011; Pamela J. Mink, Jack S. Mandel, Bonnielin K. Sceurman, & Jessica I. Lundin, 2012), and use of citation mapping tools in PubMed and Web of Science. Through these methods, we identified an additional 40 unique epidemiology articles (36 from the Mink et al reviews, and 4 using mapping techniques). Mink et al. included all studies in which a glyphosate risk estimate was measured, whether or not glyphosate was an *a priori* hypothesis, and regardless of the direction of the point estimate, *i.e.*, all null studies were included. In addition, HED reviewed the recently released European Food Safety Authority (EFSA) pesticide epidemiology systematic review (with searchable Excel spreadsheet) and identified an additional 5 epidemiology studies. Therefore, there were 55 studies included in this review (10 from the original search, 40 from citation mapping including evaluation of review article reference lists, and 5 from the EFSA systematic review).

Targeted searching using Google Scholar identified additional 63 unique articles using the following search string (Date searched 11/20/13):

> Google Scholar: [glyphosate epidemiology cohort OR "case control" OR "cross sectional" "human health risk"]

Because Google Scholar search tools are more limited than Medline or Web of Science, the original search could not limit to only articles of original research published in scholarly peer-reviewed journals, *i.e.*, news articles, commentary and reviews or editorials were initially identified. However, review of the 63 Google Scholar "hits" did not identify any additional original articles, not previously identified.

Upon completion of this process, we identified a total of 55 full text articles for inclusion. Attached appendices include a delineation of all references originally captured with the stated search string in both PubMed and Web of Science, and the final listing of included and excluded articles.

	Reference:	Included? (yes/no)
1	Abass, K., Turpeinen, M., & Pelkonen, O. (2009). An evaluation of the cytochrome P450 inhibition potential of selected pesticides in human hepatic microsomes. *Journal of Environmental Science and Health Part B-Pesticides Food Contaminants and Agricultural Wastes, 44*(6), 553-563. doi: 10.1080/03601230902997766	NO
2	Acquavella, J. F., Alexander, B. H., Mandel, J. S., Burns, C. J., & Gustin, C. (2006). Exposure misclassification in studies of agricultural pesticides: insights from biomonitoring. *Epidemiology, 17*(1), 69-74.	NO
3	Acquavella, J. F., Alexander, B. H., Mandel, J. S., Gustin, C., Baker, B., Chapman, P., & Bleeke, M. (2004). Glyphosate biomonitoring for farmers and their families: results from the Farm Family Exposure Study. *Environ Health Perspect, 112*(3), 321-326.	NO
4	Acquavella, J. F., Weber, J. A., Cullen, M. R., Cruz, O. A., Martens, M. A., Holden, L. R., . . . Farmer, D. (1999). Human ocular effects from self-reported exposures to Roundup (R) herbicides. *Human & Experimental Toxicology, 18*(8), 479-486. doi: 10.1191/096032799678847087	NO
5	Acquavella, J., Farmer, D., & Cullen, M. R. (1999). A case-control study of Non-Hodgkin lymphoma and exposure to pesticides Cancer (Vol. 86, pp. 729-731). United states.	NO
6	Adomas, B., Antczak-Marecka, J., Nalecz-Jawecki, G., & Piotrowicz-Cieslak, A. I. (2013). Phytotoxicity of Enrofloxacin Soil Pollutant to Narrow-Leaved Lupin Plant. *Polish Journal of Environmental Studies, 22*(1), 71-76.	NO
7	Alavanja, M. C., Dosemeci, M., Samanic, C., Lubin, J., Lynch, C. F., Knott, C., Blair, A. (2004). Pesticides and lung cancer risk in the agricultural health study cohort. Am J Epidemiol, 160(9), 876-885. doi: 160/9/876 [pii]	YES
8	Alavanja, M. C., Samanic, C., Dosemeci, M., Lubin, J., Tarone, R., Lynch, C. F., . . . Blair, A. (2003). Use of agricultural pesticides and prostate cancer risk in the Agricultural Health Study cohort. *Am J Epidemiol, 157*(9), 800-814.	YES

9	Andreotti, G., Freeman, L. E., Hou, L., Coble, J., Rusiecki, J., Hoppin, J. A., Alavanja, M. C. (2009). Agricultural pesticide use and pancreatic cancer risk in the Agricultural Health Study Cohort. *Int J Cancer, 124*(10), 2495-2500. doi: 10.1002/ijc.24185	YES
10	Arbuckle, T. E., Lin, Z. Q., & Mery, L. S. (2001). An exploratory analysis of the effect of pesticide exposure on the risk of spontaneous abortion in an Ontario farm population. *Environmental Health Perspectives, 109*(8), 851-857. doi: 10.2307/3454830	YES
11	Astiz, M., de Alaniz, M. J. T., & Marra, C. A. (2009). Effect of pesticides on cell survival in liver and brain rat tissues. *Ecotoxicology and Environmental Safety, 72*(7), 2025-2032. doi: 10.1016/j.ecoenv.2009.05.001	NO
12	Baker, B. A., Alexander, B. H., Mandel, J. S., Acquavella, J. F., Honeycutt, R., & Chapman, P. (2005). Farm Family Exposure Study: methods and recruitment practices for a biomonitoring study of pesticide exposure. *J Expo Anal Environ Epidemiol, 15*(6), 491-499. doi: 10.1038/sj.jea.7500427	NO
13	Band, P. R., Abanto, Z., Bert, J., Lang, B., Fang, R., Gallagher, R. P., & Le, N. D. (2011). Prostate Cancer Risk and Exposure to Pesticides in British Columbia Farmers. *Prostate, 71*(2), 168-183. doi: 10.1002/pros.21232	YES
14	Bolognesi, C., Carrasquilla, G., Volpi, S., Solomon, K. R., & Marshall, E. J. P. (2009). Biomonitoring of GeNOtoxic Risk in Agricultural Workers from Five Colombian Regions: Association to Occupational Exposure to Glyphosate. Journal of Toxicology and Environmental Health-Part a-Current Issues, 72(15-16), 986-997. doi: 10.1080/15287390902929741	NO
15	Bradberry, S. M., Proudfoot, A. T., & Vale, J. A. (2004). Glyphosate poisoning. *Toxicol Rev, 23*(3), 159-167.	NO
16	Brain, R. A., & Solomon, K. R. (2009). Comparison of the Hazards Posed to Amphibians by the Glyphosate Spray Control Program Versus the Chemical and Physical Activities of Coca Production in Colombia. *Journal of Toxicology and Environmental Health-Part a-Current Issues, 72*(15-16), 937-948. doi: 10.1080/15287390902929683	NO
17	Brown, L. M., Blair, A., Gibson, R., Everett, G. D., Cantor, K. P., Schuman, L. M., . . . Dick, F. (1990). Pesticide exposures and other agricultural risk factors for leukemia among men in Iowa and Minnesota. *Cancer Res, 50*(20), 6585-6591.	YES

18	Brown, L. M., Burmeister, L. F., Everett, G. D., & Blair, A. (1993). Pesticide exposures and multiple myeloma in Iowa men. *Cancer Causes Control, 4*(2), 153-156.	YES
19	Burger, J. (1999). Recreation, consumption of wild game, risk, and the Department of Energy sites: perceptions of people attending the Lewiston, ID, "Roundup". *J Toxicol Environ Health A, 56*(4), 221-234. doi: 10.1080/009841099158079	NO
20	Cantor, K. P., Blair, A., Everett, G., Gibson, R., Burmeister, L. F., Brown, L. M., Dick, F. R. (1992). Pesticides and other agricultural risk factors for NOn-Hodgkin's lymphoma among men in Iowa and Minnesota. Cancer Res, 52(9), 2447-2455.	YES
21	Carreon, T., Butler, M. A., Ruder, A. M., Waters, M. A., Davis-King, K. E., Calvert, G. M., Brain Canc Collaborative Study, G. (2005). Gliomas and farm pesticide exposure in women: The Upper Midwest Health Study. *Environmental Health Perspectives, 113*(5), 546-551. doi: 10.1289/ehp.7456	YES
22	Carroll, R., Metcalfe, C., Gunnell, D., Mohamed, F., & Eddleston, M. (2012). Diurnal variation in probability of death following self-poisoning in Sri Lanka-evidence for chroNOtoxicity in humans. International Journal of Epidemiology, 41(6), 1821-1828. doi: 10.1093/ije/dys191	NO
23	Chorfa, A., Betemps, D., Morignat, E., Lazizzera, C., Hogeveen, K., Andrieu, T., & Baron, T. (2013). Specific Pesticide-Dependent Increases in alpha-Synuclein Levels in Human Neuroblastoma (SH-SY5Y) and MelaNOma (SK-MEL-2) Cell Lines. Toxicological Sciences, 133(2), 289-297. doi: 10.1093/toxsci/kft076	NO
24	Clair, E., Mesnage, R., Travert, C., & Seralini, G.-E. (2012). A glyphosate-based herbicide induces necrosis and apoptosis in mature rat testicular cells in vitro, and testosterone decrease at lower levels. *Toxicology in Vitro, 26*(2), 269-279. doi: 10.1016/j.tiv.2011.12.009	NO
25	Cox, C., & Surgan, M. (2006). Unidentified inert ingredients in pesticides: Implications for human and environmental health. *Environmental Health Perspectives, 114*(12), 1803-1806.	NO
26	Curtis, K., Savitz, D., Weinberg, C., & Arbuckle, T. (1999). The effect of pesticide exposure on time to pregnancy. *Epidemiology, 10*(2), 112-117. doi: 10.1097/00001648-199903000-00005	YES

27	Curwin, B. D., Hein, M. J., Sanderson, W. T., Nishioka, M. G., ReyNOlds, S. J., Ward, E. M., & Alavanja, M. C. (2005). Pesticide contamination inside farm and NOnfarm homes. J Occup Environ Hyg, 2(7), 357-367. doi: 10.1080/15459620591001606	NO
28	Curwin, B. D., Hein, M. J., Sanderson, W. T., Striley, C., Heederik, D., Kromhout, H., Alavanja, M. C. (2007a). Pesticide dose estimates for children of Iowa farmers and NOn-farmers. Environ Res, 105(3), 307-315. doi: 10.1016/j.envres.2007.06.001	NO
29	Curwin, B. D., Hein, M. J., Sanderson, W. T., Striley, C., Heederik, D., Kromhout, H., Alavanja, M. C. (2007b). Urinary pesticide concentrations among children, mothers and fathers living in farm and NOn-farm households in iowa. Ann Occup Hyg, 51(1), 53-65. doi: 10.1093/annhyg/mel062	NO
30	Curwin, B., Sanderson, W., ReyNOlds, S., Hein, M., & Alavanja, M. (2002). Pesticide use and practices in an Iowa farm family pesticide exposure study. J Agric Saf Health, 8(4), 423-433.	NO
31	da Silva, A. C. N., Deda, D. K., da Roz, A. L., Prado, R. A., Carvalho, C. C., Viviani, V., & Leite, F. L. (2013). NaNObiosensors Based on Chemically Modified AFM Probes: A Useful Tool for Metsulfuron-Methyl Detection. Sensors, 13(2), 1477-1489. doi: 10.3390/s130201477	NO
32	Dalrymple, B. P., Peters, J. M., & Vuocolo, T. (1992). Characterisation of genes encoding two NOvel members of the aldo-keto reductase superfamily. Biochem Int, 28(4), 651-657.	NO
33	Davanzo, F., Settimi, L., Faraoni, L., Maiozzi, P., Travaglia, A., & Marcello, I. (2004). [Agricultural pesticide-related poisonings in Italy: cases reported to the Poison Control Centre of Milan in 2000-2001]. *Epidemiol Prev, 28*(6), 330-337.	NO
34	Dayton, S. B., Sandler, D. P., Blair, A., Alavanja, M., Beane Freeman, L. E., & Hoppin, J. A. (2010). Pesticide use and myocardial infarction incidence among farm women in the agricultural health study. *J Occup Environ Med, 52*(7), 693-697. doi: 10.1097/JOM.0b013e3181e66d25	YES
35	De Roos, A. J., Blair, A., Rusiecki, J. A., Hoppin, J. A., Svec, M., Dosemeci, M., Alavanja, M. C. (2005). Cancer incidence among glyphosate-exposed pesticide applicators in the Agricultural Health Study. *Environ Health Perspect, 113*(1), 49-54.	YES

36	De Roos, A. J., Zahm, S. H., Cantor, K. P., Weisenburger, D. D., Holmes, F. F., Burmeister, L. F., & Blair, A. (2003). Integrative assessment of multiple pesticides as risk factors for NOn-Hodgkin's lymphoma among men. Occup Environ Med, 60(9), E11.	YES
37	De Roos, A., Cooper, G., Alavanja, M., & Sandler, D. (2005). Rheumatoid arthritis among women in the agricultural health study: Risk associated with farming activities and exposures. *Annals of Epidemiology, 15*(10), 762-770. doi: 10.1016/j.annepidem.2005.08.001	YES
38	Delhomme, O., Raeppel, C., Teigne, D., Briand, O., & Millet, M. (2011). Analytical method for assessing potential dermal exposure to pesticides of a NOn-agricultural occupationally exposed population. Anal Bioanal Chem, 399(3), 1325-1334. doi: 10.1007/s00216-010-4434-9	NO
39	DeLuca, T. F., Cui, J., Jung, J. Y., St Gabriel, K. C., & Wall, D. P. (2012). Roundup 2.0: enabling comparative geNOmics for over 1800 geNOmes. Bioinformatics, 28(5), 715-716. doi: 10.1093/bioinformatics/bts006	NO
40	Dennis, L. K., Lynch, C. F., Sandler, D. P., & Alavanja, M. C. (2010). Pesticide use and cutaneous melaNOma in pesticide applicators in the agricultural heath study. Environ Health Perspect, 118(6), 812-817. doi: 10.1289/ehp.0901518	YES
41	Engel, L. S., Hill, D. A., Hoppin, J. A., Lubin, J. H., Lynch, C. F., Pierce, J., Alavanja, M. C. (2005). Pesticide use and breast cancer risk among farmers' wives in the agricultural health study. *Am J Epidemiol, 161*(2), 121-135. doi: 161/2/121 [pii]	YES
42	Eriksson, M., Hardell, L., Carlberg, M., & Akerman, M. (2008). Pesticide exposure as risk factor for NOn-Hodgkin lymphoma including histopathological subgroup analysis. Int J Cancer, 123(7), 1657-1663. doi: 10.1002/ijc.23589	YES
43	Evans, S. C., Shaw, E. M., & Rypstra, A. L. (2010). Exposure to a glyphosate-based herbicide affects agrobiont predatory arthropod behaviour and long-term survival. *Ecotoxicology, 19*(7), 1249-1257. doi: 10.1007/s10646-010-0509-9	NO
44	Faria, N. M., Rosa, J. A., & Facchini, L. A. (2009). [Poisoning by pesticides among family fruit farmers, Bento Goncalves, Southern Brazil]. *Rev Saude Publica, 43*(2), 335-344.	NO
45	Farmer, D. R., Lash, T. L., & Acquavella, J. F. (2005). Glyphosate results revisited. *Environ Health Perspect, 113*(6), A365-366; author reply A366-367.	NO

46	Firth, H. M., Rothstein, D. S., Herbison, G. P., & McBride, D. I. (2007). Chemical exposure among NZ farmers. *Int J Environ Health Res, 17*(1), 33-43. doi: 10.1080/09603120601124181	NO
47	Flower, K. B., Hoppin, J. A., Lynch, C. F., Blair, A., KNOtt, C., Shore, D. L., & Sandler, D. P. (2004). Cancer risk and parental pesticide application in children of agricultural health study participants. Environmental Health Perspectives, 112(5), 631-635.	YES
48	Garcia, A., Benavides, F., Fletcher, T., & Orts, E. (1998). Paternal exposure to pesticides and congenital malformations. *Scandinavian Journal of Work Environment & Health, 24*(6), 473-480.	YES
49	Garry, V. F., Harkins, M. E., Erickson, L. L., Long-Simpson, L. K., Holland, S. E., & Burroughs, B. L. (2002). Birth defects, season of conception, and sex of children born to pesticide applicators living in the Red River Valley of Minnesota, USA. *Environ Health Perspect, 110 Suppl 3*, 441-449.	YES
50	Gasnier, C., Dumont, C., Benachour, N., Clair, E., ChagNOn, M.-C., & Seralini, G.-E. (2009). Glyphosate-based herbicides are toxic and endocrine disruptors in human cell lines. Toxicology, 262(3), 184-191. doi: 10.1016/j.tox.2009.06.006	NO
51	George, J., Prasad, S., Mahmood, Z., & Shukla, Y. (2010). Studies on glyphosate-induced carciNOgenicity in mouse skin: A proteomic approach. Journal of Proteomics, 73(5), 951-964. doi: 10.1016/j.jprot.2009.12.008	NO
52	Goldner, W. S., Sandler, D. P., Yu, F., Hoppin, J. A., Kamel, F., & Levan, T. D. (2010). Pesticide use and thyroid disease among women in the Agricultural Health Study. *Am J Epidemiol, 171*(4), 455-464. doi: kwp404 [pii]	YES
53	Goldstein, D. A., Acquavella, J. F., Mannion, R. M., & Farmer, D. R. (2002). An analysis of glyphosate data from the California Environmental Protection Agency Pesticide Illness Surveillance Program. *J Toxicol Clin Toxicol, 40*(7), 885-892.	NO
54	Gui, Y.-x., Fan, X.-n., Wang, H.-m., Wang, G., & Chen, S.-d. (2012). Glyphosate induced cell death through apoptotic and autophagic mechanisms. *Neurotoxicology and Teratology, 34*(3), 342-349. doi: 10.1016/j.ntt.2012.03.005	NO
55	Hardell, L., Eriksson, M., & NOrdstrom, M. (2002). Exposure to pesticides as risk factor for NOn-Hodgkin's lymphoma and hairy cell leukemia: pooled analysis of two Swedish case-control studies. Leuk Lymphoma, 43(5), 1043-1049.	YES

56	Hardell, L., Eriksson, M., & NOrdstrom, M. (2002). Exposure to pesticides as risk factor for NOn-Hodgkin's lymphoma and hairy cell leukemia: pooled analysis of two Swedish case-control studies. Leuk Lymphoma, 43(5), 1043-1049.	YES
57	Harris, C. A., & Gaston, C. P. (2004). Effects of refining predicted chronic dietary intakes of pesticide residues: a case study using glyphosate. *Food Addit Contam, 21*(9), 857-864. doi: 10.1080/02652030412331282385	NO
58	Hewitt, A. J., Solomon, K. R., & Marshall, E. J. (2009). Spray droplet size, drift potential, and risks to NOntarget organisms from aerially applied glyphosate for coca control in Colombia. J Toxicol Environ Health A, 72(15-16), 921-929. doi: 10.1080/15287390902929667	NO
59	Heydens, W. F., Healy, C. E., Hotz, K. J., Kier, L. D., Martens, M. A., Wilson, A. G., & Farmer, D. R. (2008). GeNOtoxic potential of glyphosate formulations: mode-of-action investigations. J Agric Food Chem, 56(4), 1517-1523. doi: 10.1021/jf072581i	NO
60	Hohenadel, K., Harris, S. A., McLaughlin, J. R., Spinelli, J. J., Pahwa, P., Dosman, J. A., Blair, A. (2011). Exposure to multiple pesticides and risk of NOn-Hodgkin lymphoma in men from six Canadian provinces. Int J Environ Res Public Health, 8(6), 2320-2330. doi: 10.3390/ijerph8062320	YES
61	Hoppin, J. A., Umbach, D. M., London, S. J., Alavanja, M. C. R., & Sandler, D. P. (2002). Chemical predictors of wheeze among farmer pesticide applicators in the agricultural health study. *American Journal of Respiratory and Critical Care Medicine, 165*(5), 683-689. doi: 10.1164/rccm.2106074	YES
62	Hoppin, J. A., Umbach, D. M., London, S. J., Henneberger, P. K., Kullman, G. J., Alavanja, M. C. R., & Sandler, D. P. (2008). Pesticides and atopic and NOnatopic asthma among farm women in the agricultural health study. American Journal of Respiratory and Critical Care Medicine, 177(1), 11-18.	YES
63	Hoppin, J. A., Umbach, D. M., London, S. J., Henneberger, P. K., Kullman, G. J., Coble, J., . . . Sandler, D. P. (2009). Pesticide use and adult-onset asthma among male farmers in the Agricultural Health Study. *European Respiratory Journal, 34*(6), 1296-1303. doi: 10.1183/09031936.00005509	YES

64	Hoppin, J. A., Umbach, D. M., London, S. J., Lynch, C. F., Alavanja, M. C. R., & Sandler, D. P. (2006). Pesticides associated with wheeze among commercial pesticide applicators in the Agricultural Health Study. *American Journal of Epidemiology, 163*(12), 1129-1137. doi: 10.1093/aje/kwj138	YES
65	Hoppin, J. A., Valcin, M., Henneberger, P. K., Kullman, G. J., Umbach, D. M., London, S. J., . . . Sandier, D. P. (2007). Pesticide use and chronic bronchitis among farmers in the agricultural health study. *American Journal of Industrial Medicine, 50*(12), 969-979. doi: 10.1002/ajim.20523	YES
66	Hurtig, A. K., Sebastian, M. S., Soto, A., Shingre, A., ZambraNO, D., & Guerrero, W. (2003). Pesticide use among farmers in the Amazon Basin of Ecuador. Archives of Environmental Health, 58(4), 223-228. doi: 10.3200/aeoh.58.4.223-228	NO
67	Jauhiainen, A., Rasanen, K., Sarantila, R., Nuutinen, J., & Kangas, J. (1991). Occupational exposure of forest workers to glyphosate during brush saw spraying work. *Am Ind Hyg Assoc J, 52*(2), 61-64. doi: 10.1080/15298669191364334	NO
68	Jensen, P. C. (1989). Exposure to Roundup. *South Med J, 82*(7), 934.	NO
69	Johnson, P. D., Rimmer, D. A., Garrod, A. N., Helps, J. E., & Mawdsley, C. (2005). Operator exposure when applying amenity herbicides by all-terrain vehicles and controlled droplet applicators. *Ann Occup Hyg, 49*(1), 25-32. doi: 10.1093/annhyg/meh073	NO
70	Kamel, F., Tanner, C. M., Umbach, D. M., Hoppin, J. A., Alavanja, M. C. R., Blair, A., Sandler, D. P. (2007). Pesticide exposure and self-reported Parkinson's disease in the agricultural health study. *American Journal of Epidemiology, 165*(4), 364-374. doi: 10.1093/aje/kwk024	YES
71	Karunanayake CP, Spinelli JJ, McLaughlin JR, Dosman JA, Pahwa P, McDuffie HH. Hodgkin lymphoma and pesticides exposure in men: a Canadian case-control tudy. J Agromedicine. 2012 Jan;17(1):30-9.	YES
72	Kier, L. D., & Kirkland, D. J. (2013). Review of geNOtoxicity studies of glyphosate and glyphosate-based formulations. Critical Reviews in Toxicology, 43(4), 283-315. doi: 10.3109/10408444.2013.770820	NO

73	Kirrane, E., Hoppin, J., Kamel, F., Umbach, D., BoYES, W., DeRoos, A., Sandler, D. (2005). Retinal degeneration and other eye disorders in wives of farmer pesticide applicators enrolled in the agricultural health study. American Journal of Epidemiology, 161(11), 1020-1029. doi: 10.1093/aje/kwi140	YES
74	Koller, V. J., Furhacker, M., Nersesyan, A., Misik, M., Eisenbauer, M., & Knasmueller, S. (2012). Cytotoxic and DNA-damaging properties of glyphosate and Roundup in human-derived buccal epithelial cells. *Arch Toxicol, 86*(5), 805-813. doi: 10.1007/s00204-012-0804-8	NO
75	Koutros S, Beane Freeman LE, Lubin JH, Heltshe SL, Andreotti G, Barry KH, DellaValle CT, Hoppin JA, Sandler DP, Lynch CF, Blair A, Alavanja MC. Risk of total and aggressive prostate cancer and pesticide use in the Agricultural Health Study. Am J Epidemiol. 2013 Jan 1;177(1):59-74. doi: 10.1093/aje/kws225. Epub 2012 NOv 21. PubMed PMID: 23171882; PubMed Central PMCID: PMC3590039.	YES
76	Landgren, O., Kyle, R. A., Hoppin, J. A., Freeman, L. E. B., Cerhan, J. R., Katzmann, J. A., Alavanja, M. C. (2009). Pesticide exposure and risk of moNOclonal gammopathy of undetermined significance in the Agricultural Health Study. Blood, 113(25), 6386-6391. doi: 10.1182/blood-2009-02-203471	YES
77	Lavy, T. L., Cowell, J. E., Steinmetz, J. R., & Massey, J. H. (1992). Conifer seedling nursery worker exposure to glyphosate. *Arch Environ Contam Toxicol, 22*(1), 6-13.	NO
78	Lee, C. H., Shih, C. P., Hsu, K. H., Hung, D. Z., & Lin, C. C. (2008). The early progNOstic factors of glyphosate-surfactant intoxication. Am J Emerg Med, 26(3), 275-281. doi: 10.1016/j.ajem.2007.05.011	NO
79	Lee, W. J., Cantor, K. P., Berzofsky, J. A., Zahn, S. H., & Blair, A. (2004). NOn-Hodgkin's lymphoma among asthmatics exposed to pesticides. International Journal of Cancer, 111(2), 298-302. doi: 10.1002/ijc.20273	YES
80	Lee, W. J., Sandler, D. P., Blair, A., Samanic, C., Cross, A. J., & Alavanja, M. C. R. (2007). Pesticide use and colorectal cancer risk in the Agricultural Health Study. *International Journal of Cancer, 121*(2), 339-346. doi: 10.1002/ijc.22635	YES

81	Lee, W., Colt, J., Heineman, E., McComb, R., Weisenburger, D., Lijinsky, W., & Ward, M. (2005). Agricultural pesticide use and risk of glioma in Nebraska, United States. *Occupational and Environmental Medicine, 62*(11). doi: 10.1136/oem.2005.020230	YES
82	Lee, W., Lijinsky, W., Heineman, E., Markin, R., Weisenburger, D., & Ward, M. (2004). Agricultural pesticide use and adeNOcarciNOmas of the stomach and oesophagus. Occupational and Environmental Medicine, 61(9), 743-749. doi: 10.1136/oem.2003.011858	YES
83	Lin, N., & Garry, V. F. (2000). In vitro studies of cellular and molecular developmental toxicity of adjuvants, herbicides, and fungicides commonly used in Red River Valley, Minnesota. *J Toxicol Environ Health A, 60*(6), 423-439.	NO
84	Love, B. J., Einheuser, M. D., & Nejadhashemi, A. P. (2011). Effects on aquatic and human health due to large scale bioenergy crop expansion. *Science of the Total Environment, 409*(17), 3215-3229. doi: 10.1016/j.scitotenv.2011.05.007	NO
85	Machado-Neto, J. G., Bassini, A. J., & Aguiar, L. C. (2000). Safety of working conditions of glyphosate applicators on Eucalyptus forests using knapsack and tractor powered sprayers. *Bull Environ Contam Toxicol, 64*(3), 309-315.	NO
86	Mage, D. T. (2006). Suggested corrections to the Farm Family Exposure Study. *Environ Health Perspect, 114*(11), A633; author reply A633-634.	NO
87	Mamy, L., Gabrielle, B., & Barriuso, E. (2010). Comparative environmental impacts of glyphosate and conventional herbicides when used with glyphosate-tolerant and NOn-tolerant crops. Environmental Pollution, 158(10), 3172-3178. doi: 10.1016/j.envpol.2010.06.036	NO
88	Mandel, J. S., Alexander, B. H., Baker, B. A., Acquavella, J. F., Chapman, P., & Honeycutt, R. (2005). Biomonitoring for farm families in the farm family exposure study. *Scand J Work Environ Health, 31 Suppl 1*, 98-104; discussion 163-105.	NO
89	Mannion, A. M., & Morse, S. (2012). BiotechNOlogy in agriculture: AgroNOmic and environmental considerations and reflections based on 15 years of GM crops. Progress in Physical Geography, 36(6), 747-763. doi: 10.1177/0309133312457109	NO

90	Marc, J., Mulner-Lorillon, O., Boulben, S., Hureau, D., Durand, G., & Belle, R. (2002). Pesticide roundup provokes cell division dysfunction at the level of CDK1/cyclin B activation. *Chemical Research in Toxicology, 15*(3), 326-331. doi: 10.1021/tx015543g	NO
91	Mariager, T. P., Madsen, P. V., Ebbehoj, N. E., Schmidt, B., & Juhl, A. (2013). Severe adverse effects related to dermal exposure to a glyphosate-surfactant herbicide. *Clin Toxicol (Phila), 51*(2), 111-113. doi: 10.3109/15563650.2013.763951	NO
92	McDuffie, H. H., Pahwa, P., McLaughlin, J. R., Spinelli, J. J., Fincham, S., Dosman, J. A., . . . Choi, N. W. (2001). NOn-Hodgkin's lymphoma and specific pesticide exposures in men: cross-Canada study of pesticides and health. Cancer Epidemiol Biomarkers Prev, 10(11), 1155-1163.	YES
93	McQueen, H., Callan, A. C., & Hinwood, A. L. (2012). Estimating maternal and prenatal exposure to glyphosate in the community setting. *Int J Hyg Environ Health, 215*(6), 570-576. doi: 10.1016/j.ijheh.2011.12.002	NO
94	Mehler, L. N. (2003). Comment on "An analysis of glyphosate data from the California Environmental Protection Agency Pesticide Illness Surveillance Program". *J Toxicol Clin Toxicol, 41*(7), 1039-1040; author reply 1041.	NO
95	Mills, K., Blair, A., Freeman, L., Sandler, D., & Hoppin, J. (2009). Pesticides and Myocardial Infarction Incidence and Mortality Among Male Pesticide Applicators in the Agricultural Health Study. *American Journal of Epidemiology, 170*(7), 892-900. doi: 10.1093/aje/kwp214	YES
96	Mink, P. J., Mandel, J. S., Lundin, J. I., & Sceurman, B. K. (2011). Epidemiologic studies of glyphosate and NOn-cancer health outcomes: A review. Regulatory Toxicology and Pharmacology, 61(2), 172-184. doi: 10.1016/j.yrtph.2011.07.006	NO
97	Mink, P. J., Mandel, J. S., Sceurman, B. K., & Lundin, J. I. (2012). Epidemiologic studies of glyphosate and cancer: A review. *Regulatory Toxicology and Pharmacology, 63*(3), 440-452. doi: 10.1016/j.yrtph.2012.05.012	NO
98	Mladinic, M., Berend, S., Vrdoljak, A. L., Kopjar, N., Radic, B., & Zeljezic, D. (2009). Evaluation of GeNOme Damage and Its Relation to Oxidative Stress Induced by Glyphosate in Human Lymphocytes in Vitro. Environmental and Molecular Mutagenesis, 50(9), 800-807. doi: 10.1002/em.20495	NO

99	Mladinic, M., Perkovic, P., & Zeljezic, D. (2009). Characterization of chromatin instabilities induced by glyphosate, terbuthylazine and carbofuran using cytome FISH assay. *Toxicology Letters, 189*(2), 130-137. doi: 10.1016/j.toxlet.2009.05.012	NO
100	Montgomery, M. P., Kamel, F., Saldana, T. M., Alavanja, M. C., & Sandler, D. P. (2008). Incident diabetes and pesticide exposure among licensed pesticide applicators: Agricultural Health Study, 1993-2003. *Am J Epidemiol, 167*(10), 1235-1246. doi: 10.1093/aje/kwn028	YES
101	NOrdstrom, M., Hardell, L., Magnuson, A., Hagberg, H., & Rask-Andersen, A. (1998). Occupational exposures, animal exposure and smoking as risk factors for hairy cell leukaemia evaluated in a case-control study. British Journal of Cancer, 77(11), 2048-2052. doi: 10.1038/bjc.1998.341	YES
102	Orsi, L., Delabre, L., Monnereau, A., Delval, P., Berthou, C., Fenaux, P., . . . Clavel, J. (2009). Occupational exposure to pesticides and lymphoid neoplasms among men: results of a French case-control study. *Occupational and Environmental Medicine, 66*(5), 291-298. doi: 10.1136/oem.2008.040972	YES
103	Osten, J. R. V., Soares, A., & GuilhermiNO, L. (2005). Black-bellied whistling duck (Dendrocygna autumnalis) brain cholinesterase characterization and diagNOsis of anticholinesterase pesticide exposure in wild populations from Mexico. Environmental Toxicology and Chemistry, 24(2), 313-317.	NO
104	Pahwa, P., Karunanayake, C. P., Dosman, J. A., Spinelli, J. J., McDuffie, H. H., & McLaughlin, J. R. (2012). Multiple myeloma and exposure to pesticides: a Canadian case-control study. *J Agromedicine, 17*(1), 40-50.	YES
105	Paz-y-MiNO, C., MuNOz, M. J., Maldonado, A., Valladares, C., Cumbal, N., Herrera, C., . . . Lopez-Cortes, A. (2011). Baseline determination in social, health, and genetic areas in communities affected by glyphosate aerial spraying on the NOrtheastern Ecuadorian border. Rev Environ Health, 26(1), 45-51.	NO
106	Pedroso, J. A., & Silva, C. A. (2010). The nephrologist as a consultant for acute poisoning: epidemiology of severe poisonings in the State of Rio Grande do Sul and techniques to enhance renal elimination. *J Bras Nefrol, 32*(4), 340-348.	NO

107	Peterson, R. K. D., & Shama, L. M. (2005). A comparative risk assessment of genetically engineered, mutagenic, and conventional wheat production systems. *Transgenic Research, 14*(6), 859-875. doi: 10.1007/s11248-005-1411-8	NO
108	Potti, A., & Sehgal, I. (2005). Exposure to pesticides increases levels of uPA and uPAR in pre-malignant human prostate cells. *Environmental Toxicology and Pharmacology, 19*(2), 215-219. doi: 10.1016/j.etap.2004.04.010	NO
109	Ruder, A. M., Waters, M. A., Butler, M. A., Carreón, T., Calvert, G. M., Davis-King, K. E., Group, B. C. C. S. (2004). Gliomas and farm pesticide exposure in men: the upper midwest health study. *Arch Environ Health, 59*(12), 650-657.	YES
110	Rull, R. P., Ritz, B., & Shaw, G. M. (2006). Neural tube defects and maternal residential proximity to agricultural pesticide applications. *American Journal of Epidemiology, 163*(8), 743-753. doi: 10.1093/aje/kwj101	YES
111	Saldana, T. M., Basso, O., Hoppin, J. A., Baird, D. D., KNOtt, C., Blair, A., . . . Sandler, D. P. (2007). Pesticide exposure and self-reported gestational diabetes mellitus in the agricultural health study. Diabetes Care, 30(3), 529-534. doi: 10.2337/dc06-1832	YES
112	Sanin, L. H., Carrasquilla, G., Solomon, K. R., Cole, D. C., & Marshall, E. J. (2009). Regional differences in time to pregnancy among fertile women from five Colombian regions with different use of glyphosate. *J Toxicol Environ Health A, 72*(15-16), 949-960. doi: 10.1080/15287390902929691	YES
113	Sathyanarayana, S., Basso, O., Karr, C., LozaNO, P., Alavanja, M., Sandler, D., & Hoppin, J. (2010). Maternal Pesticide Use and Birth Weight in the Agricultural Health Study. Journal of Agromedicine, 15(2), 127-136. doi: 10.1080/10599241003622699	YES
114	Savitz, D. A., Arbuckle, T., Kaczor, D., & Curtis, K. M. (1997). Male pesticide exposure and pregnancy outcome. *Am J Epidemiol, 146*(12), 1025-1036.	YES
115	Schilmann, A., Lacasana, M., Blanco-MuNOz, J., Aguilar-GarduNO, C., Salinas-Rodriguez, A., Flores-Aldana, M., & Cebrian, M. E. (2010). Identifying pesticide use patterns among flower growers to assess occupational exposure to mixtures. Occup Environ Med, 67(5), 323-329. doi: 10.1136/oem.2009.047175	NO

116	Semal, J. (2007). Patentability of living organisms: From biopatent to bio-big-bang. *Cahiers Agricultures, 16*(1), 41-48.	NO
117	Senior, I. J., & Dale, P. J. (2002). Herbicide-tolerant crops in agriculture: oilseed rape as a case study. *Plant Breeding, 121*(2), 97-107. doi: 10.1046/j.1439-0523.2002.00688.x	NO
118	Settimi, L., Davanzo, F., Travaglia, A., Locatelli, C., Cilento, I., Volpe, C., Urbani, E. (2007). [Italian Program for Surveillance of Acute Pesticide-Related Illnesses: cases identified in 2005]. *G Ital Med Lav Ergon, 29*(3 Suppl), 264-266.	NO
119	Shi, G., Peng, M. C., & Jiang, T. (2011). MultiMSOAR 2.0: an accurate tool to identify ortholog groups among multiple geNOmes. PLoS One, 6(6), e20892. doi: 10.1371/journal.pone.0020892	NO
120	Slager, R. E., Poole, J. A., LeVan, T. D., Sandler, D. P., Alavanja, M. C., & Hoppin, J. A. (2009). Rhinitis associated with pesticide exposure among commercial pesticide applicators in the Agricultural Health Study. *Occup Environ Med, 66*(11), 718-724. doi: 10.1136/oem.2008.041798	YES
121	Slager, R. E., Simpson, S. L., Levan, T. D., Poole, J. A., Sandler, D. P., & Hoppin, J. A. (2010). Rhinitis associated with pesticide use among private pesticide applicators in the agricultural health study. *J Toxicol Environ Health A, 73*(20), 1382-1393. doi: 10.1080/15287394.2010.497443	YES
122	Smart, T., & Torres, G. (1996). Antiviral roundup. *GMHC Treat Issues, 10*(8), 6-7.	NO
123	Solomon, K. R., Anadon, A., Carrasquilla, G., Cerdeira, A. L., Marshall, J., & Sanin, L. H. (2007). Coca and poppy eradication in Colombia: environmental and human health assessment of aerially applied glyphosate. *Rev Environ Contam Toxicol, 190*, 43-125.	NO
124	Solomon, K. R., Marshall, E. J. P., & Carrasquilla, G. (2009). Human Health and Environmental Risks from the Use of Glyphosate Formulations to Control the Production of Coca in Colombia: Overview and Conclusions. *Journal of Toxicology and Environmental Health-Part a-Current Issues, 72*(15-16), 914-920. doi: 10.1080/15287390902929659	NO
125	Sowers, V. (1992). Healthcare uniform service market poised for expansion. *Text Rent, 75*(9), 38, 40, 42-34.	NO

126	Valcin, M., Henneberger, P. K., Kullman, G. J., Umbach, D. M., London, S. J., Alavanja, M. C. R., Hoppin, J. A. (2007). Chronic bronchitis among NOnsmoking farm women in the agricultural health study. Journal of Occupational and Environmental Medicine, 49(5), 574-583. doi: 10.1097/JOM.0b013e3180577768	YES
127	van Haver, E., Alink, G., Barlow, S., Cockburn, A., Flachowsky, G., Knudsen, I., Williams, A. (2008). Safety and nutritional assessment of GM plants and derived food and feed: The role of animal feeding trials. *Food and Chemical Toxicology, 46*, S2-S70. doi: 10.1016/j.fct.2008.02.008	NO
128	Varona, M., Lucia Henao, G., Diaz, S., Lancheros, A., Murcia, A., Rodriguez, N., & Hugo Alvarez, V. (2009). Effects of aerial applications of the herbicide,glyphosate and insecticides on human health. *Biomedica, 29*(3), 456-475.	NO
129	Wang, G., Fan, X. N., Tan, Y. Y., Cheng, Q., & Chen, S. D. (2011). Parkinsonism after chronic occupational exposure to glyphosate *Parkinsonism Relat Disord* (Vol. 17, pp. 486-487). England.	NO
130	WECHSLER, L., CHECKOWAY, H., FRANKLIN, G., & COSTA, L. (1991). A PILOT-STUDY OF OCCUPATIONAL AND ENVIRONMENTAL RISK-FACTORS FOR PARKINSONS-DISEASE. *Neurotoxicology, 12*(3), 387-392.	YES
131	Wester, R. C., Melendres, J., Serranzana, S., & Maibach, H. I. (1994). Time-response necessary in validation for extraction of pesticides from cloth patches used in field exposure studies. *Arch Environ Contam Toxicol, 27*(2), 276-280.	NO
132	Williams, A. L., Watson, R. E., & DeSesso, J. M. (2012). DEVELOPMENTAL AND REPRODUCTIVE OUTCOMES IN HUMANS AND ANIMALS AFTER GLYPHOSATE EXPOSURE: A CRITICAL ANALYSIS. *Journal of Toxicology and Environmental Health-Part B-Critical Reviews, 15*(1), 39-96. doi: 10.1080/10937404.2012.632361	NO
133	Williams, G. M., Kroes, R., & Munro, I. C. (2000). Safety evaluation and risk assessment of the herbicide Roundup and its active ingredient, glyphosate, for humans. *Regul Toxicol Pharmacol, 31*(2 Pt 1), 117-165. doi: 10.1006/rtph.1999.1371	NO

134	Yiin JH, Ruder AM, Stewart PA, Waters MA, Carreón T, Butler MA, Calvert GM, Davis-King KE, Schulte PA, Mandel JS, Morton RF, Reding DJ, Rosenman KD; Brain Cancer Collaborative Study Group. The Upper Midwest Health Study: a case-control study of pesticide applicators and risk of glioma. Environ Health. 2012 Jun 12;11:39.	YES
135	Zawahir, S., Roberts, D. M., Palangasinghe, C., Mohamed, F., Eddleston, M., Dawson, A. H., Gawarammana, I. (2009). Acute intentional self-poisoning with a herbicide product containing fenoxaprop-P-ethyl, ethoxysulfuron, and isoxadifen ethyl: a prospective observational study. Clin Toxicol (Phila), 47(8), 792-797. doi: 10.1080/15563650903174810	NO